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NOTICE.

THE serial *Indian Museum Notes*, issued by the Trustees of the Indian Museum, Calcutta, under the authority of the Government of India, Revenue and Agricultural Department, is to take the place of *Notes on Economic Entomology*, of which two numbers have appeared.

The parts of the serial will be published from time to time as materials accumulate. Communications are invited; they should be addressed to—

The Editor,
Indian Museum Notes,
Calcutta.

Correspondence connected with Economic Entomology should be accompanied by specimens of the insects to which reference is made. Caterpillars, grubs, and other soft-bodied insects can be sent in alcohol; chrysalids and cocoons, alive, and packed lightly in leaves or grass; other insects, dried and pinned or wrapped in soft paper. Live insects should be sent when there is a reasonable probability of their surviving the journey. Caterpillars, grubs, and other immature insects can often be only approximately determined; they should therefore, where possible, be accompanied by specimens of the mature insects into which they transform; when, however, this is not possible, they should still be sent, as they can always be determined approximately, and uncertainty must necessarily arise in discussing insects when actual reference to the specimens cannot be made.

The papers in the first number of *Indian Museum Notes* deal with Indian insect pests, and are based on material which has been sent to the Museum by the Revenue and Agricultural Department of the Government of India, by the Departments of Agriculture attached to the various Local Governments, by the Forest Department, and also by many private individuals in different parts of India. For the views expressed the authors of the respective *notes* are alone responsible.

THE EDITOR.

INDIAN MUSEUM,
April 1889.

NOTES ON INDIAN INSECT PESTS.

RHYNCHOTA.

BY

E. T. ATKINSON, B.A., C.S., C.I.E.

The Rice Sapper (*Leptocorisa acuta*).

Plate I, fig. 1; a, enlarged; b, natural size.

In 1886, some specimens of an insect, belonging to the order Rhynchota and section Heteroptera, were received from Mr. J. Lee-Warner, of Tinnevelly, and were found to have considerably injured the autumn rice. They were identified with *Leptocorisa acuta*, Thunb., a wide-spreading species found all over the East on rice. In the North-Western Provinces (Gorakhpur), Chota-Nagpur and Assam, this insect is known as *gandhi*, and in Assam attacks especially the *ahu* rice. In Tinnevelly it is called the *munju vandu*, or rice-juice sucker or sapper. There is every reason to believe that the numerous references which are given below all belong to one and the same species or its local varieties. This species is represented in South America by the closely allied *Leptocorisa filiformis*, Fabr.; in Central and North America, by *L. tipuloides*, De Geer; in Africa by *L. apicalis*, Westw.; and in Australia by *Mutusca brevicornis*, Dallas. The general colour of the Indian species varies from virescent (which in old specimens fades to sordid yellow) to testaceous, and even brownish-testaceous: the rings, at the base of the 2-4 joints of the antennæ, vary in the space occupied by them, and, in colour, from white to fulvous and testaceous, and are sometimes very faint; the first joint of the antennæ is sometimes entirely testaceous: abdomen above reddish orange, beneath entirely flavescent or with a row of four brown spots on each side. Those without spots beneath are smaller, and, in the Indian Museum collection, are from Assam and Sikkim; the spotted forms are from Calcutta, Behar, Tinnevelly and Ceylon, but in some of these latter specimens the spots are so nearly obsolete as to be barely traceable.

Mr. D. J. Macpherson, C.S., of Bankura, writes that this insect appeared in the sudder sub-division of his district, where it is called *bhoma*, and damaged the early rice crop when ripening (September). In the Proceedings of the Agri-Horticultural Society (18th May 1871) it is

noticed that seedlings from some experimental sowings of Carolina paddy were attacked by the *gandhi*, whilst the indigenous seedlings escaped. The pest was also reported from Partabgarh in Oudh, and is there described as greenish-brown, having an offensive smell: it settles on the rice when milky and sucks out the juice, leaving the husk dry: as many as six to ten of these insects have been seen on a single ear. The Deputy Commissioner of Hazaribagh also reports the rice-bug (*Gandhi makkhi*) as attacking the *gora* and *badhi* rice while in the ear: it destroys up to three-fourths of the crop and generally appears in a year when the rain sets in early (May). The insect in the larval state is most destructive, sucking out the juices from the halm, which withers and turns yellow, but we know nothing of its life-history, how many broods there are; where the eggs are laid and apparently hibernate; whether any attempts at destroying the pest have been made and with what result. Smoking the fields attacked by burning vegetable refuse to windward might be tried, but the area is too large for the ordinary methods of insecticide preparations.

Leptocorisa acuta, Thunberg.

Cimex acutus, Thunberg, Nov. Ins. Spec. ii, p. 34 (1783), Atkinson, Proc. As. Soc. Beng. Jan. 1887. China.

Var. *a.*—*Cimex angustatus*, Fabr., Mant. Ins. ii, p. 308 (1787).

Cimex angustus, Gmelin, ed., Syst. Nat. i (4), p. 2193 (1788).

Gerris oratorius, Fabr., Ent. Syst. iv, p. 191 (1794); Syst. Rhyng., p. 261 (1803). India.

Gerris angustatus, Fabr., Ent. Syst. iv, p. 191 (1794); Syst. Rhyng., p. 262 (1803); Stål, Hem. Fabr. i, p. 66 (1868); Ofv. K. V.-A., Förh., p. 658 (1870). China, Philippines.

Myodochus trinotatus, Herr. Schäff., Wanz. Ins. viii, p. 95, t. 281, f. 863 (1848). Java.

Leptocorisa angustata, Walker, Cat. Het. iv, p. 173 (1871). India, China, Australia.

Leptocorisa (*Rhabdocoris*) *acuta*, Stål, En. Hem. iii, p. 86 (1873), China, Java, Australia.

Gerris varicornis, Fabr., Syst. Rhyng., 260 (1803); Wolff, Ic. Cim. v, p. 202, t. 20, f. 196 (1811); Stål, Hem. Fabr. i, p. 67 (1868) excl. syn. *G. apicalis*; Ofv., K.V.-A., Förh., p. 658 (1870). Tranquebar, Philippines.

Leptocorisa flavida, Guérin, Voy. La Coquille, Zool. ii, p. 178, t. 12, f. 12 (1830).

Coreus (*Stenocephalus*) *varicornis*, Burm., Nov. Act. Ac. Leop., xvi., Sup., p. 298 (1834).

Myodochus varicornis, Burm. Handb. Ent. ii (i), p. 325 (1835). Sumatra, Philippines.

Leptocorisa chinensis, Dallas, List Hem. ii, p. 483 (1852); Walker, Cat. Het. iv, p. 172 (1871). China.

Var. *b.*—*Leptocorisa bengalensis*, Westw., Hope Cat. Hem. ii, p. 18 (1842); Stål, En. Hem. iii, p. 87 (1873). Bengal.

Leptocorisa maculiventris, Dallas, l. c., p. 484 (1852); Walker, l. c., p. 172 (1871)—(?)

Leptocorisa varicornis, Dallas, l. c., p. 484 (1852); Walker, l. c., p. 172 (1871); Stål, En. Hem. iii, p. 86 (1873); Distant, A. M. N. H. (5) iii, p. 127 (1879). Assam.

Var. *a.*—Above greyish, beneath entirely flavescent: antennæ and feet somewhat testaceous (*G. angustatus*, Fabr.). Virescent; antennæ obscurely flavescent, last joint white at base: beneath flavescent, immaculate: abdomen above rufous (*G. oratorius*, Fabr.) Sordid greenish-yellow: 2-4 joints of antennæ yellow at base, black at apex (*M. binotatus*, Herr. Schäff.). Long, 18 mill. Testaceous; thorax greenish, with the lateral margins whitish: membrane with a black spot on the inner basal angle: abdomen beneath yellowish-white: antennæ with basal joint fulvous, black externally and at apex: 2-3 joints black, fulvous at base; last joint brown, fulvous at base (*L. chinensis*, Dallas). Long. 16-17 mill. Body linear, above flavescent, margin of thorax and hemelytra whitish: antennæ elongate, filiform, 5-jointed (?), first joint very short, globose, rest cylindrical, equal, inserted between the eyes, as long as the body, joints flavescent at base, black at apex: rostrum porrect, longer than head, inflexed, inserted below the clypeus; sheath 4-jointed, the joints subequal, last a little shorter, somewhat obtuse: labium porrect, elongate, very fine, corneous, subulate, as long as the first joint of the sheath; setæ three, equal, subulate, as long as the sheath: wings hyaline with a small common fuscous spot at the base: beneath flavescent (*G. varicornis*, Fabr.).

Var. *b.*—Above fulvous testaceous: membrane with a brown curved streak on the inner margin, within the basal angle: abdomen above reddish-orange, beneath with a row of four brown spots on each side (*L. maculiventris*, Dallas). Long. 17 mill. Virescent-luteous: antennæ brunneous-fulvous, 2-4 joints paler at the base: a thin arcuate fulvous line at the base of the membrane: median segments of the abdomen furnished beneath on both sides with a fuscous spot: feet fulvous (*L. bengalensis*, Westw.). Long. 16½ mill.

The Indian Museum possesses specimens from Ceylon, S. India, Tinnevelly, Bombay, Karachi, Behar, Sikkim, Calcutta, Assam.

Chora-Poka.

A bottle containing specimens labelled *Chora-poka*, received from Mr. R. Cornish, C.S., of Balasore, contained the larvæ of several species of Rhynchota belonging to different families. The local report states that

when the sesamum crop is gathered and stacked on the threshing-floor, the insects appear in vast numbers and eat out the kernel of the seed, leaving only the husk. To prevent the attacks of the insect, the stalks are steeped in water for a day, and thus induce a partial decomposition which produces a bad smell that appears to be distasteful to the insects and checks their progress. Amongst the insects found in the bottle are the small pentatomid, *Carbula biguttata*, Fabr.,—a species belonging to the family Lygæidæ,—and the larvæ of several species in too early a stage for identification. It is not considered probable that any of these insects are concerned in eating out the interior of the sesamum seeds.

The Green Bug. (*Nezara viridula*, Linn.).

Atkinson, Jl. As. Soc. Ben., Pt. II, p. 119 (1888).

This cosmopolitan insect, found almost in every country in the world, has been reported as occurring on potato halms in Bangalore (Mr. J. Cameron).

Capsidæ.

Mr. Atkinson has under preparation a monograph of the genus *Helopeltis*, Sign., to be illustrated with figures of all the described species of this genus. It is well known to all interested in the tea industry as the 'mosquito-blight;' and would seem to be of great economical interest, both in Assam and all other tea-growing countries.

Disphinctus humeralis, Walker.

Monalonion id, Walker, Cat. Lep. Het. vi, p. 162 (1873).

This is another pest belonging to the family Capsidæ, which has been recently discovered attacking the cinchona at Mungphu in Sikkim. It does not, however, seem to have done much damage, and has for some time disappeared.

Walker's description is as follows :—

"Red, slender, shining, very finely punctured: head short, triangular, eyes black, prominent: rostrum reaching the intermediate coxæ; antennæ black, very slender; first joint piceous, rather stout, a little shorter than the head; second joint more than thrice as long as the first; pronotum contracted in front, with two transverse furrows, and with a large black spot on each side posteriorly: legs luteous, slender corium and membrane hyaline, brownish cinereous; veins brown."

Long., 8⅓ mill. Reported from Malacca.

Jassidæ.

Certain species of the Homopterous section of the Rhynchota found attacking the mango were brought to notice in a letter from Mr. W. Gollan, of the Botanical Gardens, at Saháranpur. Mr. Gollan wrote—

"I should like to try 'Buhach' on the mango-bug. By this I do not mean the pest so common in Bengal which attacks the ripe or ripening fruit, but another which

appears to subsist upon the juices of the flowers, young leaves, and young shoots of the mango. I dare say you know the insect I mean. It is a small, dark-coloured wedge-shaped insect, provided with wings, but it cannot fly far, as, when disturbed, it flies about among the leaves for a few seconds and immediately settles upon them again. They are found upon the mango all summer, but do most harm, when the trees are in flower by damaging the reproductive organs, and thus causing interference with the setting of the fruit. I have tried mixtures of soap, tobacco, sulphur, kerosine diluted with milk, &c., upon them, but without noticeable effect. We have not had many of them this year, but there are a few upon some of the trees and quite sufficient of them to experiment with. Last year, and the year before, we had them in myriads, and both these seasons we had light crops of fruit, but this year a fine crop has set, and this I attribute to the comparative absence of these insects. I once sent it to the Agri-Horticultural Society to be named. Mr. Blechynden, the Deputy Secretary of the Society, sent it on to a Mr. F. Moore, of Penge, and he pronounced it to be a cicadid belonging to the genus Jassus, but he did not seem to be able to give a more definite name for it. If you have not examined this insect I shall send you some in spirit."

To this letter the following reply was given by the assistant in charge of the Entomological section of the Museum:—

"Mr. Blechynden, of the Agri-Horticultural Society, some time since made over to me some of your specimens of the mango cicadid, which you say injures the reproductive organs of the flowers. I am interested to hear of the failure of soap, tobacco, sulphur, and kerosine and the milk mixtures on it.

"With regard to the Buhach, I am not aware of any place where it can at present be obtained in India, but I applied to the Buhach Company in California about six weeks ago with reference to its introduction, and if any of the insecticide is sent to me in time to be of service, I will at once forward some to you.

"I feel, however, very doubtful myself as to whether the Buhach would be of much use against this bug: it seems to be generally useful against soft-bodied insects, such as caterpillars, only.

"Kerosine and soap solution or milk seems to be the most promising application. You say 'kerosine diluted with milk' was a failure; I wonder if the mixture was churned into a kind of butter before it was diluted with water and sprayed on to the trees; otherwise some parts of the trees would be pretty certain to get sprayed with pure milk and water and a very small area with pure kerosine. It is worth noticing that a stronger wash is often effective when a weaker one fails, and kerosine and soap solution seems to be generally more effective than kerosine and milk."

The insects were sent by Mr. Atkinson to M. Lethierry, of Lille, who pronounced them to be new to science and has named the three species discovered *Idiocerus clypealis, niveosparsus,* and *atkinsoni,* respectively. The descriptions will appear in the Journal, Asiatic Society, and in a future number of these notes. In the meantime, it is desirable that steps should be taken during the ensuing season to investigate their life-history more thoroughly. Mr. E. Cotes suggests that a further trial should be given to kerosine emulsion, which should be thoroughly churned and applied in a very fine spray, as suggested for scale insects (p. 7); and also that an attempt should be made to ascertain where the insect lays its eggs and what becomes of it during the greater part of the year when the mango trees are not in flower.

Aphidæ.

Cerataphis, sp.

Plate I, fig. 2, enlarged.

In August 1888, some leaves of cinchona infested by a new aphid were sent to Mr. G. B. Buckton, who reports as follows:—

"Although the specimens are in bad condition, partly caused by the spirit being so strong that the contents of the insect are dissolved out of them, they prove to be very interesting, inasmuch as they probably belong to the genus *Cerataphis*, Lichtenstein, described by Mr. Buckton (British Aphides IV, 198, Royal Society). The disc of white-wax is characteristic of this coccus-like aphis. Only one species of this genus has yet been described, and this (*Cerataphis lataniæ*, Licht.) has been found to infest the palm, orchis, calamus and other tropical plants in conservatories in Europe. I believe that but three specimens of the winged form have been identified in Europe. Before I can give an opinion as to the species on the cinchona, I should like to have more examples preserved in, say, a 10 per cent. solution of alcohol, or even weaker than this. Single leaves, folded in single pieces of tissue paper and packed separately between layers of cotton-wool, a little tightly pressed in a small box would be sufficient. I have seen some very minute insects thus sent from Mexico."

The figures show the larva and pupa, the latter enclosed in its sheath. The larva seems to be almost blind, whilst the winged insect is well provided with eyes. Mr. J. Gammie of the cinchona plantation at Mungphu in Sikkim has kindly promised to send Mr. Buckton fresh specimens when the season for them comes round, which will be about April.

Pemphigus Cinchona, Buckton in litt.

This aphis, together with the larva of a coccinella, was forwarded to Mr. Buckton, who named it provisionally *Pemphigus cinchonæ*. Further specimens are awaited before it can be formally described.

Coccidæ.

Mr. Atkinson has recently described a new genus and species of coccid (*Pseudopulvinaria sikkimensis*) found on the cinchona in Sikkim. It appears in the cold-weather in the form of a flour-like substance on the underside of the leaves of oak, chestnut and cinchona, and matures about April. It has not yet spread enough to do any considerable damage.

Dactylopius adonidum, Linn., already described in the Journal of the Asiatic Society (Part II, p. 288, 1886) has been procured from Mysore, where it occurs on *Cedrela* sp., *Acrocarpus fraxinifolius*, *Ficus mysorensis*, *F. glomerata*, *F. asperrima*, &c., and does considerable damage to the coffee bushes. Mr. Anderson, of Barguai (Mysore), has sent some remarkable examples of the curious black fungoid growth which seems invariably to accompany this insect, and, covering the twigs, effectually rottens and kills them. He describes it as a black, felted substance, extremely like a fungoid growth: in appearance it is very like the sooty

accumulation that occurs on bottles in cellars and which wine-merchants sometimes exhibit *in situ* on bottles, as evidence of the time that they have been kept. That which accompanies the *Lecanium nigrum*, Nietner, in Ceylon, has been named *Trisporium gardneri* by Berkeley, and is described as having at first the appearance of a thin, diluted black-wash, but, rapidly increasing in density, within two or three months it quite covers and blackens the leaves and other parts of the trees, finally almost resembling moss. Its period of growth, in Ceylon, appears to extend over about twelve months, when it is replaced by a young growth, or both it and the scale abandon the tree, and, when leaving the tree, the fungus peels off in large flakes. Mr. Nietner writes—

'As the occupation of a coffee or any other tree (by scale-insects) gives rise to the appearance of a glutinous saccharine substance (honey-dew, which is either a secretion of the scale, or its extravasated sap that flows from the wounded tree, or, more probably, a combination of both), which disappears with the scale, and as the fungus does exactly the same, I have no doubt that its vegetation depends upon the glutinous saccharine substance."

Mr. Anderson also noticed the occurrence of this honey-dew in connection with *Dactylopius adonidum* in Mysore, and writes that the tree, when attacked, bleeds or gums so profusely that the ground all round the stem is made moist.

Mr. Maskell, in his account of the scale-insects of New Zealand, (p. 15), also calls this transparent, gelatinous, fluid excretion, 'honey-dew,' and remarks that it is apparently analogous to that exuding from the Aphides, Psyllidæ and Aleurodidæ. It varies in quantity with the species present, and appears to be excreted by a cylindrical tube, exserted from the ano-genital orifice after the manner of a telescope, the furthest-extended portion of the tube, being the most slender. In the genus Cœlostoma, when this tube is pushed out to its full extent, there appears at its furthest extremity a minute globule of yellowish, nearly transparent, glutinous fluid, which rapidly expands like a soap-bubble, and, then, suddenly breaking off, falls in spray on the leaf beneath, as the coccids are usually attached to the underside of a leaf. It therefore injures the leaf in two ways, by stopping up the stomata of the leaf itself, and by forming a nidus for fungoid growths which rapidly accumulate and kill those portions of the plant on which they appear. Removing the fungus is not sufficient, but, in addition, the scale-insect itself must be sought out and destroyed by the kerosine emulsion described in No. 2 of these Notes and which for reference is reproduced here—

"An emulsion resembling butter can be produced in a few minutes by churning with a force-pump two parts of kerosine and one part of sour-milk, or soap solution in a pail; emulsions, made with soap solutions being generally found to be the more effective. The liquids should be at about blood-heat. This emulsion may be diluted with from nine to fifty parts of water, which should be thoroughly mixed with one part of the emulsion.

"The strength of the dilution must vary according to the nature of the insect to be dealt with, as well as to the nature of the plant; but finely sprayed in twelve parts

of the water to one of the emulsion, it will kill most insects without injury to the plant."

It should be applied through a spray nozzle (see pl. 4, fig. 4)—

"The nozzle which best combines the necessary qualities is undoubtedly the eddy or cyclone nozzle, consisting of a small circular chamber with two flat sides, one of them screwed on, so as to be readily removed. Its principal feature consists in the inlet, through which the liquid is forced, being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid, which issues in a funnel-shaped spray through the central outlet in the adjustable cap. The breadth or height, fineness or coarseness, of the spray, depends on certain details in the proportions of the parts, and specially in the central outlet.

"To drive the liquid through the nozzle some kind of force-pump is required, and a great number have at different times been experimented with, some of them being of a most complicated nature. It is perhaps not of any very great consequence which particular form is adopted for use in India; but the aquapult force-pump, which has been arranged to be worked entirely by one man, who also distributes the spray, seems to be about the best suited for general use in a country where economy in labour is generally not so great an object as economy in the cost of apparatus."

Lecanium acuminatum, Sign.

Ann. Soc. Ent. France, p. 397, t. 12, f. 1 (1873).

Plate I, fig. 3, c, *shows the ventral surface (after Signoret); fig. 3* a, *the dorsal surface, and fig. 3* b, *a side view, the two latter magnified about 7 times.*

This coccid was reported by Signoret as occurring on orchids in the conservatories of the Luxembourg. It has since been found on the mango in Ceylon by Mr. E. E. Green, and has been identified by Mr. Douglas with the species described by Signoret. Only the adult form has been found, which is thus described—

Body briefly oval, acuminate towards the apex, rounded, very broad towards the extremity: antennæ 7-jointed, fourth longest, third equal to the fifth and sixth taken together, which are the shortest, the seventh as long as the fifth and sixth taken together. Feet broad, flattened; tarsi short, hardly half the length of the tibiæ. Differs from *L. hesperidum* in the form of the body and the shortness of the tarsi: the embryo, too, is oval, rounded, and very broad where the abdomen commences. Long., 2-3 millimetres.

This coccid is reported by Mr. Green to do some damage to the mang leaves which wither and fall off when attacked.

RHOPALOCERA.

BY

L. DE NICÉVILLE, F.E.S., C.M.Z.S.

A Butterfly injurious to Rice (*Suastus gremius*, Fabricius).

Plate 1, fig. 4, male imago; 4, b, full-fed larva; 4, c, front and side views of two different pupæ—all from Calcutta specimens and natural size.

Report.

A single report has been received regarding this pest, drawn up by Hafizar Rahaman Ahmed, Tehsildar of the Government Estate, Noanand, in the Balasore District, Bengal, forwarded by the Collector of the Balasore District through the Director of Land Records and Agriculture, Bengal, to the Indian Museum, Calcutta. Accompanying the report seven full-fed larvæ and one pupa of the pest were sent, together with some young paddy leaves on which the larvæ had been feeding. The Tehsildar reports that the pest is known by the local name of "Pattanai," that the larva is about an inch in length, light green in colour, with a deep green line extending down the middle of the back from one extremity to the other. He notes that when they are exposed to the sun they hide themselves [presumably in the shelter, which all larvæ of the family to which it belongs invariably construct for themselves of the leaves on which they live], but when exposed to the rain their movements on the leaves are active. He says also that they eat paddy alone, but this is not correct. He also says that they are attracted at night by the light of a lantern. If this is correct, it is an interesting fact, and one, as far as I know, not before noted with regard to any Lepidopterous larva. He further notes that they build nests [*i.e.* shelters], that they owe their origin to the dirty water, and to the reeds grown on the fields, also that no proper remedy has yet been invented by the cultivators of this part of the country for their destruction, but that it is believed that continual heavy rains destroy them by plunging them under water, but it is left to nature to remove the pest. These insects do great damage to the paddy plants, but happily their ravages are confined to the younger and tender plants only.

Zoological position of the insect.

From the larvæ and pupa sent I am able almost with certainty to identify the pest as *Suastus gremius*, Fabricius, a butterfly of the family *Hesperiidæ*, of the sub-order

Rhopalocera, of the order *Lepidoptera*. This butterfly is very widely-spread, occurring throughout India except the desert tracts, and in Ceylon. The butterfly expands about an inch and three quarters, is of a glossy brown colour on the upper side, the fore wing with a pair of conjoined spots at the end of the discoidal cell, and a series of six spots curving round the middle of the wing (all these spots are pale yellow). The under side of the forewing is nearly similarly marked; but the hind wing, which is unspotted on the upper side, has about six small round black spots in the middle of the wing. The opposite sexes are almost exactly alike.

Life history.

The earlier stages of this insect have not hitherto been published. I have repeatedly bred it (often from the egg) in Calcutta, where it feeds on the date palm. I was not previously aware, till reading the Tehsildar's report, that it had any other food plant. He says it only eats young paddy in the larval state; I rather doubt this, as if it will eat the particularly fibrous, dry, tough, and hard leaves of the date, surely it will eat too the older paddy leaves, which cannot compare in hardness to the date leaves at all ages. According to my observations the egg is laid singly on the upper side of the leaves of date palms, generally near the base of each subdivision or frond of the leaf. It is large, very hard, dome-shaped, widest at the base, rapidly decreasing in width towards the apex, much wider than high, the usual crater-like depression at the top (micropyle), from the edges of which proceed coarse ribs varying in number from twelve to fifteen, the usual number being fourteen; colour French-grey, just before the young larva emerges, turning to very delicate pale pink. Larva at first stage dull red throughout. When full-fed it measures just an inch in length when at rest; the body smooth, pale bluish-green, the segments denoted by pale yellowish lines and but slightly constricted, the whole surface covered with minute dark green spots, and crossed, especially at the constrictions dividing the segments, by fine depressed lines; a dark green dorsal line, the spiracles black. The body is nearly cylindrical, but tapers towards both ends, the anal segment flattened anteriorly. The head-case is hard and rough, covered with fine depressions, a double pale line across the crown and one at each side, the rest dark brown. Legs and under side of body pale green. The larva, when large enough, rolls up a leaf or else joins together two or three leaves, closing the edges by silk threads, but leaving an opening at each end. When quite small, it makes a shelter of a part of a leaf only. It comes out only to eat, as far as I have observed, and retreats into its shelter when its meal is over or if frightened, either backwards or forwards with equal celerity. The pupa is enclosed in a rolled-up leaf, the inside of which is lined with soft silk, out of which flies when opened a quantity of fine white waxy powder with which the pupa is thickly covered. The pupa is pale yellowish green,

the head very square and blunt, the eyes dark brown, but no other markings, the body quite plain and smooth throughout.

Damage of the pest.

The Tehsildar says that this insect does "great damage to the paddy plants." I am inclined somewhat to doubt this fact. The butterfly is by no means a common one, and, as the paddy is growing for a part of the year only, the butterfly has a chance of perpetuating its race only by living on some other plants but paddy, as, when the latter is reaped, the insects living upon it, no matter in which stage, egg, larva or pupa, would be certainly destroyed. Any butterflies that might be on the wing would escape certainly, but they probably live but for a short time, certainly not till the next season's paddy has commenced to grow, so their only chance of perpetuating the race would be to lay their eggs on some other plant, which would almost certainly be difficult to find in suitable quantities. I think, therefore, except under most exceptional circumstances, the damage done to the growing rice would be but trifling, especially as it appears to eat the leaves only.

Remedies.

Hand-picking might be resorted to to destroy the pest, but would probably be too expensive. Both larva and pupa could be easily found, as they spin several of the paddy stems and leaves together to form their shelters. The simplest way to destroy the pest, and which would be absolutely effectual, would be to raise the earthen walls, or bunds, round the affected nurseries or fields, and submerge the rice under water for a short time. In no stage (except perhaps the egg) could the insect survive this drowning process, and it would do no harm to the rice.

A Ceylon Cardamom Pest (*Lampides elpis*, Godart).

Plate I, fig. 5, a, *male imago; fig. 5,* b, *larva; fig. 5,* c, *cardamom capsules, two of which have been punctured by the larvæ,—all natural size.*

Reports.

Two reports only have been received regarding this pest. The first report is contained in a pamphlet entitled "Note on Cardamom Cultivation," by Mr. T. C. Owen (Colombo, A. M. and J. Ferguson, 1883), who notes—

"Of the *enemies* which attack cardamoms the most serious is an insect which bores a circular hole in the capsules and cleans out the inside; young plantations seem much more liable to this pest than older ones. In the former case as much as 80 to 90 per cent. will sometimes be attackedand destroyed in this way; proximity to patana seems also the cause of increased liability to these attacks. Applications of wood-ash, lime, or anything of a like nature, are said to be beneficial."

Mr. Owen failed to identify the insect which does the damage, and it has remained unknown till quite recently, when Mr. E. Ernest Green, of the Eton Estate, Pundul-oya, Ceylon, found a full-grown larva inside a capsule, and, on breeding it, found it to be *Lampides elpis*, Godart, a

common butterfly of the Indo-Malayan region belonging to the family *Lycænidæ*. The second report above referred to consists of a letter from Mr. Green, dated 21st November, 1888, addressed to Mr. E. C. Cotes, of the Indian Museum, Calcutta, enclosing drawings of the larva and cardamom fruit (reproduced on Plate I), and a letter to the writer, dated 23rd December, 1888. He writes—

"It is a curious thing that, although the damage caused by the larva of this insect is so general, it was only after a long time and much trouble that I caught the criminal red-handed. I had for some time suspected this pretty little butterfly, as it haunts the cardamom clearings in large numbers. Other planters seem to have been equally unsuccessful in determining the cause of the damage. My drawing was made from a single specimen found *in situ* in the cardamom capsule. I unfortunately neglected to make a drawing of the pupa. The larva was full-fed at the time [of capture], and pupated almost immediately upon the side of the box in which it was confined. Since then I have failed in obtaining other specimens. This is probably because the insects are all now on the wing; the larval state, no doubt, occurs earlier in the year during the growth of the young fruit. At the time of the cardamom harvest, when one's attention is more especially drawn to the damage, the insects have all vacated [the capsules], and are possibly lying as pupæ among st the shrivelled leaves and stalks. When the next fruiting season commences, I inten d to make a very careful search for the eggs and larva, and, if successful, will send you a series for examination. I do not think the larva attracts ants, or I should have noticed the ants frequenting the cardamom stools. In drawing the larva I did not notice any secretive gland or retractile tentacles. As regards the food of *L. elpis*, its natural food-plant is, no doubt, one or more of the allied *Scitamineæ*, which abound in all Ceylon jungles—*Curcuma*, *Amomum*, &c."

With regard to Mr. Green's remarks about ants, they are in reply to my questions on the subject. Many larvæ of the *Lycænidæ*, including an allied species, *Lampides ælianus*, Fabricius, have two retractile tentacles on the twelfth segment, and a gland on the dorsal line of the eleventh segment, which latter, at the will of the larva, gives off a sweet liquid, of which ants are extremely fond; in consequence of this many species of *Lycænidæ*, which possess this gland are most carefully tended and guarded by ants, who appear to make "cows" of them, much in the same way as they utilise *Aphidæ*, *Coccidæ*, &c. Mr. Green also notes that "Ordinarily from 5 to 10 per cent. of the fruit capsules are perforated by this insect."

Zoological position of the insect.

This pest is a butterfly of the genus *Lampides*, of the family *Lycænidæ*, of the sub-order *Rhopalocera*, of the order *Lepidoptera*. The genus is a purely tropical and sub-tropical oriental one, and occurs almost throughout India, in Ceylon, in the Andaman and Nicobar Isles, in Burma and in the Malay Peninsula and Archipelago. The male butterfly is of a very beautiful, pale metallic azure-blue on the upper side, with a narrow black border to both wings; the hind wing has sometimes a series of black marginal spots, and there is always a short black white-tipped filamentous tail-like process to each hind wing near the anal angle. The female is pale dull (not metallic) bluish-white on the upper side, the outer black margins much broader, and the black spots on the margin of the hind

wing considerably more prominent. The underside of both wings of both sexes is pale brownish, crossed by numerous more or less broken prominent white lines. The expanse of the open wings is about an inch and a half.

Life history.

It is almost certain that this butterfly, at low elevations, flies all the year round, and that there are a constant succession of broods. The female probably lays her eggs on the flower buds of the cardamoms (*Elettaria cardamomum*), as is the case with another Lycænid (*Virachola isocrates*, Fabricius) whose larva lives on fruit. The young larva emerges from the egg within a very few days and commences to eat the flower bud or young fruit, burrowing into its centre for that purpose.

Mr. Green describes the larva when full-fed as "dull, pale green, tinged with red on dorsal area; three reddish narrow dorsal stripes; spiracles minute, black; head small, brown, retracted beneath the second segment; length ·55 of an inch. Pupa smooth, pale dull yellowish-brown, marbled and spotted with dark brown, spots coalescing into three irregular dorsal stripes." An allied species, *L. ælianus*, Fabricius, has been bred by the writer in Calcutta on the leaves of *Heynea trijuga*, Roxburgh, and in Java by Dr. Horsfield on *Butea frondosa*. It is most singular that two species of one genus should have such dissimilar habits. Only two other genera of Indian *Lycænidæ* are known to live on fruits, *Virachola* with two species, *Deudorix* with one.

Within the fruit all its larval state is passed; it grows with the fruit and lives on the fruit entirely, probably never venturing outside unless the fruit to which it has hitherto been attached should for any reason become unsuitable to it, when it would seek a fresh one, and immediately bore into its centre. When full-fed, Mr. Green surmises that it leaves the fruit, and turns to a pupa or chrysalis amongst the shrivelled leaves and stalks. This is contrary to my experience of the habits of *V. isocrates* and *V. perse*, which, in nature, usually pupate within the fruit on which they have lived. The pupal state would last but a few days probably, when the butterfly would appear, and the second cycle of life begin by the females laying a new batch of eggs. As the cardamom grows, as far as I know, in South India and Ceylon only, it is certain that it cannot be the legitimate food-plant of this butterfly throughout its great range. Mr. Green, however, appears to have been the first to breed the insect, and thus to discover at least one of its food-plants. It is probable, like other pests, that *L. elpis* feeds upon some jungle plant, but that, finding the cultivated cardamoms quite to its taste, it has taken to them and rapidly increased in numbers, owing to its new food-plant being provided for it in such great abundance.

Damage of the pest.

Mr. Owen estimates the damage done by this pest to be sometimes as much as 80 to 90 per cent. to young plantations. Mr. Green states that "ordinarily from 5 to 10 per cent. of the fruit capsules are perforated by this insect."

Remedies.

Mr. Owen states that "applications of wood-ash, lime, or anything of a like nature are said to be beneficial." It should be remembered that Mr. Owen did not know what insect constituted the pest, nor its life-history. I magine his remedy is meant to be applied to the earth surrounding the plants, which might keep away slugs and worms, but would be absolutely useless in the case of this insect. The only remedy I can suggest is to catch and kill all the butterfles that can be seen. Small boys, provided with butterfly nets, should be able to satisfactorily account for the greater number of butterflies frequenting a given area, to prevent the females laying their eggs being the object of the slaughter. The butterflies have a slow, flapping flight, and are very conspicuous, so their capture is very easy. Once the eggs are laid no further remedy is possible, I think. To prevent the increase of the butterfly it would be advantageous to hunt for, and collect, all the capsules with holes in them, and to destroy them by fire or burial. This search for affected fruits would, however, be very tedious and expensive, so I fear impracticable. To kill one gravid female butterfly, with perhaps two or three hundred eggs in her body, each egg representing the loss of a capsule, would be a much more effectual remedy.

FURTHER NOTES ON INSECT PESTS.

BY

E. C. COTES,

ASSISTANT IN THE INDIAN MUSEUM, CALCUTTA.

1.—FURTHER NOTES ON THE WHEAT AND RICE WEEVIL[1].

Will isolation preserve wheat from weevils?

FROM inquiries made in the early part of 1888, there appeared to be a somewhat widespread idea that, although wheat is apparently free from weevil when it leaves the fields and village granaries, yet, that it will invariably develop weevil whenever it is stored so as to be exposed to the air, quite independently of any further contamination by weevils.

This idea may be accounted for by the fact that, after the eggs are laid, a certain period elapses before anything is seen of the resulting weevils, and consequently that grain, stored in a perfectly new and clean godown, may develop weevil owing to its having been already contaminated when it was put there, though to all outward appearance it was perfectly clean. It appeared, however, of importance to settle the question definitely, for it is evident that, while, on the one hand, isolating and disinfecting store-houses, to get rid of the weevil, will be of no use whatever if the eggs are already laid in the wheat when it leaves the fields; on the other hand, if the weevil is a purely store-house pest, the isolating and disinfecting of the store-houses seems to be the most rational method of dealing with it.

With a view therefore of settling the question, the Directors of Land Records and Agriculture in the North-Western Provinces and Punjab sent down, last hot weather, to the Museum, a series of half maund samples of wheat, and besides these the writer obtained a few small samples, which were rubbed out by hand from the ear, in his presence, at the experimental Farm at Cawnpore. These samples were distributed to different places where there were thought to be no weevils, and exposed to the air, throughout the whole of the rains, in order to ascertain to what

[1] For a general account of this insect (*Calandra oryzæ*) see No. I of "Notes on Economic Entomology, 1888."

extent they would be attacked. On the 14th of November, when the rains were well over, a small sample of each was closed up and sent to Mr. H. M. Ross, who had kindly undertaken to furnish a report.

The experiments are not so definite as could be wished, and it will be well to repeat them through another year; but they seem to indicate pretty clearly that, when taken fresh from the field and carefully isolated from contamination by weevils, although exposed to the air, wheat can be indefinitely preserved from attack, and hence that the weevil does not deposit its eggs while the grain is standing in the ear in the fields. At the same time, however, the experiments clearly show that while it is easy enough to preserve hard red wheat, the very greatest precautions have to be taken in order to preserve soft white wheat from attack.

It should be noticed that in the case of samples (especially of the soft varieties) reported upon as 'practically undamaged but with a few stray weevils in them,' these weevils could only have been introduced late in the rains; for had even one or two weevils succeeded in laying their eggs in the wheat, before it reached the Museum, they would have occasioned appreciable damage, owing to the rapidity of their reproduction. The writer, therefore, concludes that during the latter part of the rains, a few stray individuals, from the badly infested samples, found their way into the clean samples, which were deposited in different parts of the Museum and No. 1, Sudder Street, in places supposed to be well isolated, but which in reality were not sufficiently removed from infested quarters.

The following is a detailed account of the experiments, with the remarks made on them by Mr. H. M. Ross :—

Experiment 1.

Samples A, B, B2, and N, were rubbed out from the ear at the Cawnpore Experimental Farm on 28th March 1888, were unpacked and exposed to the air in small bottles on the 27th April, and were kept until the end of September in No. 1, Sudder Street, where they were thoroughly isolated; they were sent in the end of September, during the writer's absence, to the Entomology room in the Museum,and thus exposed for a short time to possible contamination by weevils.[1]

Mr. Ross reports on them in November:—

"Sample A. soft white wheat, with admixture of about 20 % of hard,—contains one or two live weevils; no real damage done.

"Sample B. Soft white wheat, with small admixture of hard grains and barley. Has evidently been damp from exposure in the rains. No damage from weevils.

"Sample B2. Practically identical with sample B.

"Sample N. Soft white wheat, with admixture of reddish grains. No damage from weevils."

[1] Weevils are not very active so late in the rains, but this exposure is, in the writer's opinion, sufficient to account for the few stray weevils found in the samples in November.

Experiment 2.

Sample M was obtained at the same time as samples in experiment No. I. But early in the rains it was sent to the Entomology room, where it remained throughout the whole of the rains, within easy reach of stray weevils.

Mr. Ross reports on it in November:—

"Sample M quite rotten and full of weevils."

Experiment 3.

Sample D, taken on 14th November 1888 from a half-maund tin of that year's wheat, which was received from the Director of Land Records and Agriculture, North-Western Provinces, in May, and was exposed to the air in the Museum, in a well isolated position, from May to November.

Mr. Ross reports on it in November:—

"Soft white wheat, with small admixture of hard grains; the soft grains, almost without exception, badly weevilled; the hard grains mostly free from weevils."

Experiment 4.

Samples E and F were taken on 14th November 1888 from two half-maund tins of that year's wheat, received from the Director of Land Records and Agriculture, North-Western Provinces, on 12th June, and exposed to the air throughout the whole of the rains in the Museum verandah, where they were well isolated from weevils.

Mr. Ross reports on them as follows:—

"Sample E, hard, white wheat, known in Calcutta as 'Allyghur quality' (from the district where it is largely grown); no signs of weevilling. Have never seen any sample or bulk of this quality containing weevils.

"Sample F, soft, white wheat, with hardish shell, contains one or two weevils, but no real damage done."

Experiment 5.

Sample K, was taken on 14th November 1888 from a tin of wheat, which was received from the Director of Land Records and Agriculture, Punjab, on 25th May (marked new wheat from a threshing floor); it was exposed to the air throughout the whole of the rains in No. 1, Sudder Street, where it was well isolated.

Mr. Ross reports on it as follows:—

"Sample K, hard, red wheat (gunga jelli); have never known pure gunga jelli to weevil."

Experiment 6.

Sample L was taken, 14th November 1888, from a tin of old wheat from a godown in Sialkot. This tin was received from the Director of Land Records and Agriculture, Punjab, on 25th May, and was exposed to the air, throughout the rains, in the Entomology room, where it was not isolated from weevils.

Mr. Ross reports on it in November as follows:—

"Sample L, old wheat, with small admixture of barley, both alike destroyed by weevils."

Experiment 7.

Samples H, H2, and G, were taken on 14th November 1888 from three half-maund tins of wheat, received from the Director of Land Records and Agriculture, North-

Western Provinces, on the 2nd July 1888; these tins had been exposed to the air throughout the rains, in different parts of No. 1, Sudder Street, where they were well isolated.

Mr. Ross reports on them in November as follows:—

"Samples H and H2, mixed hard and soft white wheat, with further admixture of gunga jelli (hard red), contains one or two weevils, but no real damage done.

"Sample G, hard red wheat (gunga jelli), with small admixture of soft white grains; one or two weevils visible. Have never known *pure* gunga jelli to weevil."

Mr. Ross remarks:—

"The foregoing results agree with the experience of the trade, *viz.* hard wheats are practically safe from the attacks of the weevil; of the soft wheats samples A, B, B2, and N, rubbed out from the ear by hand and isolated since March last, have practically escaped damage. Sample D, of similar quality, wheat is badly weevilled, with the exception of its hard grains, which have escaped.

"If stored in ordinary godowns during the past season, specimens A, B, B2, J, N, and possibly F, would have weevilled as badly as D.

"Nothing would be gained by extending the time during which these samples were exposed. If wheat escapes the weevil during the rains, it will suffer but little afterwards."

Experiment 8.

Besides the samples above noticed, there were two half-maund tins of new wheat (one being soft white and the other hard red), which were received in May from the Director of Land Records and Agriculture, North-Western Provinces and Oudh. These were exposed to the air, in the Office of the Revenue and Agricultural Department, Calcutta, where they were thoroughly isolated from the time they were received until 20th December.

Mr. Ross reports on them in December:—

"Both are quite free from weevils, and the white wheat is '*superior quality soft* white wheat. The isolation seems to have been quite effective in these cases."

Experiment 9.

Some ears of very soft bearded wheat, and some ears of barley were brought down from Cawnpore in April, and exposed to the air in Calcutta in the Entomology room (within easy reach of loose weevils) throughout the whole of the hot weather and rains. On examining them in November, the grains of wheat in the ear were all untouched by weevil, while the barley, which had been obtained at the same time and kept under precisely similar conditions, was badly weevilled.

The weevil in paddy.

The following extracts are taken from a letter, dated 29th August, from the Agricultural Officer of Ranchi, which has been forwarded by the Director of Land Records and Agriculture in Bengal—

"The rice weevil is never met with in the open. However minute it might be, it could not possibly escape detection if it was in the habit of frequenting rice fields while laying its eggs.

"So far as my inquiries go, the weevil is never found in paddy (*i.e.* unhuske drice) however long it may have been kept in the granary. If the eggs were laid, as is sup-

posed by people, while the rice was still in the husk, paddy would be equally subject to the attacks of the weevil.

"It is well known that *siddha* rice (*i.e.* rice which has been steeped for an hour or so in water at nearly boiling) is infested by the weevil to the same extent as *atap* (or unsteeped rice): a fact which shows beyond doubt that the eggs could not have been laid while the rice was still in the husk, for in that case they would have lost their vitality during the boiling operation.

"I have examined several samples of rice retailed in the Ranchi market by petty dealers from neighbouring villages: all these were singularly free from weevils, a fact which can be explained by supposing greater cleanliness observed by villagers in the matter of storing the grain, but which is mainly attributable in my opinion to the habit of keeping rice always in the husk till is required for sale or private consumption."

Bisulphide of carbon.

The following extract is taken from Mr. W. S. Price's report of experiments made in the Bigapur district to test the efficacy of bisulphide of carbon in protecting grain from weevil.

The report has been received from the Director of Land Records and Agriculture, Bombay, who adds that the experiments were undertaken at the suggestion of the Government of India.

The experiments in this case show the failure of this chemical to protect Jowari grain from the attack of weevil.

The wheat weevil, *Calandra oryzæ*, has hitherto only been definitely recorded as attacking wheat, rice, maize and barley; but it seems probable that it is the one here mentioned as attacking Jowari grain (millet):—

Dharwar, 22nd August 1888.

"I made two experiments in December last in the Hugund Taluka with the bisulphide of carbon that was sent to me, one in the town of Ilkal, and the other in the town of Hungund. The reports from the Mamledar of Hungund show that the Jowari grain experimented on has been attacked by weevil.

"For the experiment in Ilkal, about 320 ℔ of new Jowari were stored in a wicker-basket, shape and size of a cask. The basket was well plastered with a mixture of cowdung and earth. About $3\frac{1}{4}$ oz. of the chemical were plunged into the grain to about half-way down into the basket in the way directed in the Government Resolution, No. 6093, dated 9th September last. The mouth of the basket was then closed by a deep plaster of mud, a layer of leaves of the neem tree being placed between the grain and mud plaster. The experiment in Hungund was conducted in the same way, and on the same kind of grain. The amount of grain used was 336 ℔, into which about 4 oz. of the chemical were placed."

Sulphur fumes.

With regard to sulphur fumes for killing weevils, Dr. Giles, of Hoshangabad, writes on the 22nd September—

"The weevil has attacked my store of grain in the prison, and I first tried sulphur fumes. The godown, however, was too large to be sufficiently tightly closed, and

though a good many were killed, a good many survived—the greater number I think. I am now trying neem leaves, and I am inclined to think it will answer, but will let you know when sufficient time has elapsed to test the question."

The weevil in Burma.

The Director of Land Records and Agriculture, Burma, writes—

"In Lower Burma the Burmans do not, as a rule, keep clean rice for long. But in Upper Burma it is largely stored. The merchants" (in Mandalay) "told me that they suffered great loss from weevils and would gladly try any insecticide that Government recommended. The rice is usually kept in gunny bags containing 225 lb of rice each."

A series of reports on weevil in unhusked rice has been received from the Director of Land Records and Agriculture in Burma.

The reports are in the form of extracts from letters from Messrs. Bullock, Brothers & Co., and the Deputy Commissioners of the following places, Hanthawaddy, Prome, Pegu, Bassein, Irrawaddy, and Thongwa. It seemes unnecessary to give the reports in full, but, while some of them notice damage in unhusked rice by weevils, the majority of them may be summed up in the words of the Deputy Commissoner of Pegu, who writes :—

"Weevils do not do any appreciable damage to paddy, apparently because the outer husk is very hard. When rice is stored for some time after being husked, weevils attack it, but the Burmans are not in the habit of storing husked rice. They do not want any insecticides."

This agrees with experince in Bengal, and it would seem probable that in the cases when unhusked rice is attacked by insects, the damage is done by a species of grain-moth, which is often to be found in large numbers, and not by the weevil, which only attacks the rice after the removal of the husk.

The weevilling of rice in England.

Mr. H. M. Ross writes—

"You will recollect that I promised to ascertain what I could for you concerning the weevilling of rice in warehouses at home. My correspondent writes as follows:—'Of the dock gentlemen and wharfingers to whom I spoke, many refused to admit that rice weevilled at all—and getting statistics on the subject I found to be totally out of the question, as none exist. However, the more experienced allow that in damp weather rice does weevil to a certain extent, but it is under 1 per cent. per annum (*i. e.* the loss in weight from weevilling). One instance I had given me where the rice had been warehoused for four years and there was absolutely no sign of weevilling whatever'."

Note.—This illustrates how susceptible the weevil is to cold, for however clean the rice may be when it is put on board in Calcutta, at least a few weevils are almost always to be found in it, and these, under the conditions of the Calcutta climate, would very soon affect the whole shipment. Miss Ormerod has observed what a slow and difficult process it is

for the weevil to develop in wheat after it reaches England; and the same would seem to hold good with rice.

The weevil in the hot weather in the North-West Provinces.

With regard to the question of how the weevil passes the hot weather in the North-West Provinces, where the godowns become excessively hot and dry, the Secretary to the Government of India, in the Revenue and Agricultural Department, has forwarded the following note by Mr. G. Cane, who writes from Delhi on 16th July:—

"A wheat weevil "sursi" (red) was found alive on a wall of a godown early in June before any rain fell. Also a "goon" (black), which frequents gram and other grain, was found similarly. Although most of these weevils die in the hot months, it is evident a few survive. The godowns are now crowded with them.

A Demerara remedy.

Mr. J. Blackwood writes[1] that he hears from one of the leading rice importers in Demerara, that there they attract ants to the rice piles by sugar, and the ants destroy the weevils. (See the action of ants in Demerara in protecting sugarcane from Borer moth, p. 26.)

Conclusions.

In the above correspondence and experiments the points which seem to be chiefly of importance are as follows:—

I.—The confirmation of the theory that the weevil is a purely granary-pest, and that grain can therefore be preserved by isolation, and other precautions against infection, after it leaves the fields; the hard varieties, of wheat being easily protected, while in the case of the soft varieties, which offer less resistance to attack, protection from infection, though possible, is a matter of very considerable difficulty.

II.—The observation of the wandering propensity of the weevil, which makes perfect isolation very difficult to obtain in the neighbourhood of infested localities.

III.—The confirmation of the supposition that rice is free from the attack of weevil so long as it lies in the husk, which seems to be an efficient protection.

IV.—The observation that the weevil does not develop to any considerable extent in grain after it reaches England.

V.—The doubt which has been thrown upon the efficacy of any of the substances, bisulphide of carbon, neem leaves, and sulphur fumes, to preserve grain that lies in an infected store-house.

VI.—The observation that in the case of wheat the ear is a protection against weevils, while barley is as much subject to attack when in the ear as when taken out of it.

[1] Letter dated Calcutta, 15th January, 1889.

2.—THE SUGARCANE BORER MOTH.

Diatraea saccharalis,[1] Fabr.

Plate II, fig. 2 a *moth*, b *larva* (*dorsal view*), c *larva* (*side view*), e *pupa* (*all natural size*); *fig. 2* f *pupa* (*enlarged*), g *piece of sugarcane* (*natl. size*) *to show tunnels.*

The larvæ of this moth bore into the stalks of sugarcane, often thereby setting up putrefaction, so that the whole stalk becomes worthless.

The zoological position of the insect.

It has not yet been satisfactorily determined whether the sugarcane borer, found in different parts of the world, belongs exclusively to a single species, or whether there are several closely allied species, all of which damage sugarcane by boring into it. Until, therefore, this question has been definitely settled the Fabrician name of *saccharalis* may continue to be applied[2] to the pest wherever it occurs, and the insect may be determined zoologically as a Pyralid moth, belonging to the genus *Diatraea* and to the species *saccharalis* of Fabricius.

Occurrence of the pest in India.

Sugarcane, in different parts of the world has, for at least the last hundred years, been known to be subject to the attack, either of this pest or of others so closely allied to it as to be scarcely distinguishable from it, and during the last year information has been sent to the Museum of damage done to sugarcane in several parts of India, where the pest would seem to have long been known, though but little has been recorded concerning it.

In 1857 Babu Joykissen Mukerji described[3] the total destruction, by the pest which he calls '*dhosah*,' of an imported variety of sugarcane (known as the Bombay or red sugarcane) in the districts of Rungpur, Hooghly, and a portion of Burdwan. The cultivation of this variety had been carried on for some years, and had proved very profitable, but when the pest appeared its cultivation had to be entirely given up, as it was found to be very much more subject to attack than the country varieties of cane.

In the Indian Museum are specimens of the pest, which were received in 1885, with the information that the insect had done great injury to sugarcane in Dhulia.

In 1888, the Personal Assistant to the Director of Land Records and Agriculture, North-Western Provinces, wrote[4] that the pest, which ap-

[1] The thanks of the writer are due to Mr. R. Blechynden, of the Agri-Horticultural Society of India, for help in hunting up the previous history of this pest.

[2] This is the view taken by Dr. Riley in his paper on the pest in the Entomology Report of the U. S. Department of Agriculture, 1880, page 240.

[3] In a paper published by the Agri-Horticultural Society, India, Volume IX, page 355 1857).

[4] In a letter dated 1st September.

pears in dry seasons, had destroyed as much as a fourth of the sugarcane crop in the neighbourhood of the Cawnpore Experimental Farm.

The Special Manager of the Dhaukora Wards Estate writes [1] that the pest, which is known locally as *Mandaruah*, has this year (1888) done injury to the sugarcane crops in several parts of the estate.

The Collector of Ganjam also notices [2] injury done by this insect, which is known as *Monjikila purugu*.

The Agricultural Officer of Burdwan and Seebpur, writes [3] that the loss occasioned by the pest, sometimes amounts to fully one-fourth of the cane crops of a neighbourhood.

The pest in other parts of the world.

With regard to injury by the pest in other parts of the world :—

In the year 1750 Hughes mentions [4] injury done to the cane in Barbadoes by the larvae of small moths which are likely to have been the same as the borer.

Porter notices [5] that the pest was found fatally destructive in Guadaloupe in 1785 and 1786.

Beckford notices [6] the presence of the borer in Jamaica in 1790.

In 1828 the Revd. L. Guilding wrote [7] an account of the borer in St. Vincent, describing it as *Diatraea sacchari*.

Westwood mentions [8] the pest as destructive to sugarcane in Jamaica in 1841.

About the year 1856 the insect did great damage to cane in Mauritius, [9] into which island it was supposed to have been introduced from Ceylon.

In 1857 the borers were very abundant along the Lower Mississippi in the United States.[10]

About the year 1879 the borer did great damage to the sugarcane crop in British Guiana.[11]

[1] In a letter dated 23rd September to the Collector of Mymensingh that was forwarded by the Director of Land Records and Agriculture Bengal.

[2] In a report forwarded by the Revenue and Agricultural Department.

[3] In a letter dated 4th July which was forwarded by the Director of Land Records and Agriculture, Bengal.

[4] See Roth's Animal Parasites of the Sugarcane, page 12, (1885).

[5] "Nature and properties of sugarcane," by G. R. Porter, London, (1830).

[6] See Roth, Animal Parasites of the Sugarcane, p. 8, (1885).

[7] Trans. Soc. Arts., Vol. XLVI, p. 143, (1828).

[8] *Gardener's Chronicle*, 5th July 1856, page 453.

[9] Bojer's Report of the Select Committee appointed to examine the extent of the damage done by the cane-borer in Mauritius, 1856 ; reprinted in the *Sugarcane* for 1873, (see Roth's Parasites of the Sugarcane).

[10] See Dr. Riley's paper in the Entomology Report of the U. S. Department of Agriculture, 1880, page 240.

[11] See papers by Miss Ormerod in Proc. Ent. Soc. Lond. 1879, pp. 33 and 36 ; and 1880, page 16.

In 1880 Dr. Riley reported [1] on the insect as injurious in the United States.

In 1885 Mr. H. Ling Roth described [2] the insect as occasionally very destructive to sugarcane in Queensland, Australia.

The Agricultural Officer of Burdwan and Seebpore writes [3]—

"The sugarcane planting season extends from the beginning of February to the end of May. If there be no rains [4] in April or May, and if the cane fields are not frequently irrigated, which, from the scarcity of water at this time, is hardly possible, the pest makes its appearance. The pest first shows itself by the drying of the middle stalk of the plant, and is hence called by the ryots the *Majera* (a Bengalee term meaning relating to the middle); on pulling, the stalk now easily comes out, and its lower end is found to have become a rotten mass. Very soon the whole plant dies away, and from the root stock a number of smaller plants make their appearance to be in their turn attacked by the worm. If the rains hold off a long time, or if the fields are not thoroughly irrigated, three or four generations of plants are in this way attacked and destroyed. At last, when the rains set in, the fields become free from the insect, and a number of sickly-looking cane plants shoot out, but these make very little progress and never attain the proper size of the cane plant. If only one generation of plants is lost, and if this happens at an early stage of the growth of the plant, the damage done is not much."

Nature of the injury in India.

The life history of the insect has not yet been fully studied in India, but what has been observed agrees so closely with the observations made on the corresponding sugarcane pests of other parts of the world, that we may safely infer the rest, and the following account therefore is taken from Dr. Riley's paper [5] on the pest in America, where, however, the insect is likely to take rather longer to pass through the various stages of its existence than in the warm climate of India.

Life history.

The parent moth lays her eggs upon the leaves of the young cane near the axils, and the young borer, hatching in the course of a few days, penetrates the stalk at or near the joint, and commences to tunnel through the soft pith. The eggs are flat and circular, one twenty-fifth of an inch in diameter, and are white when first deposited, turning yellow as they

[1] Riley, l. c.

[2] See his 'Animal Parasites of the Sugarcane.'

[3] In a letter dated Calcutta 4th July, which has been forwarded by the Director of Land Records and Agriculture, Bengal.

[4] It is noticeable that while considerable injury by the pest is almost universally supposed to take place only when moisture is deficient, Ling Roth, in his account of the pest in Australia notices particularly that the pest occurs in "wet springs." (See his 'Animal Parasites of the Sugarcane')

[5] Report, U. S. Department of Agriculture, Entomology, 1880, p. 240.

approach the hatching point. The growth of the borer worm must be very rapid, less than thirty days being probably occupied in the larval state. The borers are quite active, and occasionally leave their burrows and crawl about upon the outside of the stalk, seeking another place to enter. The full-grown borer is about an inch long, rather slender, nearly cylindrical, and cream white in general colour, but speckled [1] with black spots with a yellow head and black mouth-parts. Upon attaining its full size, it bores to the outside of the cane and makes a large round hole for its future exit—a hole which is usually at least one-fifth of an inch in diameter. It then retires into its burrow and transforms, a short distance from the opening, into a slender brown pupa,[2] three quarters of an inch long. The pupa state lasts but a few days and then the moth makes its exit. The moth has a spread of wings of about an inch and a quarter, and is of a light, greyish-brown color. With the female moth the hind wings are of nearly the same color with the fore wings, but with the male the former are silvery white. There are several broods in the course of the season, and the insects hybernate almost exclusively in the larval or "worm" state. During the winter they are to be found most abundantly in the seed cane, but also in the discarded tops, and to a slighter extent in the stubble.

Food plants of the worm other than sugarcane.

The Agricultural Officer of Burdwan and Seebpore notices [3] that he has seen the Kash plant (*Saccharum spontaneum*), attacked by the insect in the same way as sugarcane is attacked. Specimens of what appear to be the larvæ of the sugarcane borer have been received from the Collector of Ganjam, who writes [4] that they destroy paddy and brinjal plants, besides sugarcane. Similar specimens have also been received from the Agricultural Officer of Ranchi, who reports them as injurious to brinjal; and from Mr. Woodrow, of Poona, where they bore into jowari stalks and are said to make the plant poisonous to cattle. (See p. 28.) Dr. Riley notices [5] a very closely allied, if not identical, insect that bores into corn (maize) stalks in America.

Parasites and natural enemies of the pest.

In British Guiana [6] the pest is subject to the attack of ants which live in the cane fields, and are supposed to wage continual warfare against the borers; and in Mau-

[1] Dr. Riley found that the black speckles were not always present, but the specimens sent to the Museum have them plainly visible.

[2] The insect which damaged sugarcane in Mauritius about the year 1856 is said (see Bojer's Report) to have spun itself up in the leaves of the plant instead of transforming into a pupa in its burrow. In the case, however, of the insects reared in the Museum, the pupæ were formed in the burrows in the cane.

[3] In a letter dated Calcutta, 4th July, forwarded by the Director of Land Records and Agriculture, Bengal.

[4] In a report forwarded by the Revenue and Agricultural Department.

[5] Report of U. S. Department of Agriculture, Division Entomology, 1880.

[6] See Miss Ormerod's paper in Proc. Ent. Soc., Lond., 1879, p. 33.

ritius the chrysalids of the borer were found to be subject to the attack of mites; no evidence has yet been obtained of any effect produced in either of these ways upon the numbers of the sugarcane pest in India, though the writer has observed large numbers of a chalcid fly which is parasitic upon the allied, or identical, jowaree borer. (See p. 29.)

Remedies.

A large number of remedies have been proposed for the pest, and it seems to be pretty well established that it can be to a great extent controlled by the burning or burying all the discarded tops, and clearing the fields of all waste sugarcane stalks after the crop has been taken; for, as the insect passes the winter as a larva inside the sugarcane, if these are destroyed, there are no moths in the spring to lay the eggs which produce the next year's "borers." The waste tops, however, should be carefully gathered together and removed from the field before being burnt, for if they are burnt carelessly, on the field itself, many predaceous insects will be liable to be destroyed, which take shelter in the ground and assist in reducing the numbers of the pest.

The following may be noticed among the remedies that have been suggested :—

Guilding recommends[1] that all the dry and useless leaves, under which he says the moth lays its eggs, should be stripped off: he claims that this treatment has been found effective in removing the pest.

Porter quotes[2] the practice of "introducing a pinch of quicklime into the heart of the young cane" for the destruction of the pest.

Westwood notices[3] that in Jamaica in 1841, the ravages of the borer were to a great extent checked by allowing the refuse to accumulate upon the grounds, and burning them there, the old roots subsequently throwing up more vigorous shoots.

Miss Ormerod,[4] in writing of the pest in British Guiana about the year 1879, quotes the practice of cutting back the cane below the surface of the ground, covering the plant with mould, and adding a handful of lime. The cutting out of the affected canes was tried on one estate over 246 acres, the result being considered satisfactory. In this case the canes cut out were put through the mill, and sufficient rum and megus obtained from them to pay expenses. Miss Ormerod also quotes the practice of steeping the cane for 48 hours in water before planting it, a treatment which was thought on one plantation, where it was tried, to destroy the hybernating larvæ without injury to the cane. It appears from the inquiries instituted in British Guiana, that it is a mistake to burn the refuse sugarcane on the fields themselves, as this destroys the ants, which, when unmolested, rendered valuable assistance in keeping down the pest. The plan therefore approved was to burn the refuse cane after collecting it in heaps outside the fields.

Dr. Riley recommends[5] burning all "tops" during the winter so as to destroy the larvæ which hybernate in them; selecting seed cane from the least infested portion of the plantation and laying it down in furrows during the winter, covered with earth as deeply as should be found possible without inducing decay, and only uncovering it as

[1] Trans. Soc. Arts, Vol. XLVI, p. 43 (1828).

[2] Nature and Properties of Sugarcane, by G. R. Porter, London, 1830.

[3] *Gardener's Chronicle*, 5th July 1856, p. 453.

[4] Proc. Ent. Soc., Lond. 1880, p. 16; and 1879, pp. 33 and 36.

[5] In his report on the insect.

it is wanted in the spring for planting out, thus preventing the egress of moths from the larvæ which have hybernated in the seed cane.

Roth writes that [1] "he has kept the pest under control in Queensland by sending boys with sharp pocket-knives along the rows of cane. The boys spotted the dead or dying shoots and cut them off as close as possible to the parent cutting. They then opened the shoot and destroyed the fat grub. In some cases, however, the grub had migrated to a fresh shoot which as yet did not show any sign of decay, and thus escaped." Roth adds that "while dirty fields were being destroyed wholesale by the grub, clean fields were not infected to any such extent."

Bibliography.

H. Ling Roth's papers on the Animal Parasites of the Sugarcane in Mackay (Australia): "*Sugarcane,*" March and April 1885, and February 1886, which include a bibliography of the subject.

Dr. Riley's papers in the Entomology Reports of the U. S. Department of Agriculture, 1880, p. 240, and 1881, p. 135, on the pest in the United States, which include a general account of the insect.

Baboo Joykissen Mookerjee's paper in the Journ. Agri.-Hort. Soc. Ind., Vol. IX, p. 355, 1857, on the pest in Rungpore, Hooghly, and a portion of Burdwan.

Miss Ormerod's papers in the Proc. Ent. Soc. London, 1880, p. 16, and 1879, pp. 33 and 36, on the pest in British Guiana.

Guilding's paper in Trans. Soc. Arts, Vol. 46, p. 143 (1828), on the borer in the West Indies.

Boger's Report of the Select Committee appointed for the purpose of examining the extent of the damage caused by the cane-borer in the Mauritius, 1856.[2]

Westwood's papers in the *Gardener's Chronicle,* dated 5th July 1856, p. 453, and in the Journal of the Linn. Soc. Lond., 1857, p. 102, on the borer in Mauritius.

Gill's paper in "*The Sugarcane,*" August 1879, on cane-borers.[2]

Fabricius (J. C.) Beskrivelse over den skadlige sukker og Bomuldsorm i Vest Indien, og om Zygaena pugionis Forwandling (*Phalaena saccharalis, Noctua gossypii.*) In Skrifter of Naturhist Selsk, 1794, Bd. 3, Heft. 2, p. 63—67; Extr. Bullet. Soc. Philom. 1792, T. 1, p. 28, Götting Journ. 1798, Bd. 1, Heft. 1, p. 137—143. (See Hagen's Bibl. Ent., under Fabricius, No. 15.)

Beckford's descriptive account of the Island of Jamaica, published 1790, Vol. II, pp. 52—54.[2]

Hughes' "Natural History of Barbadoes" Fol. London, 1750, pp. 245—247.[2]

[1] In his "Animal Parasites of the sugarcane," p. 12, 1885.

[2] Not seen by the writer.

3.—THE SORGHUM-BORER.

Mr. G. Marshall Woodrow, of Poona, has forwarded [1] some stalks of *Sorghum vulgare* (Great Millet, *jowaree* or *juár*) injured by an insect which is said to be very destructive in the Deccan, and is believed by the ryots to be poisonous to cattle. In the account of *Sorghum vulgare* in "Field and Garden Crops," page 27, Duthie and Fuller write :—

"The most peculiar disease to which juár is liable is that which makes the young stalks poisonous to cattle if eaten by them when semi-parched from want of rain. Of this fact there can be no doubt; in the scarcity of 1877 large numbers of cattle were known to perish from this cause, their bodies becoming inflated after a meal of the young juár plants, and death ensuing shortly afterwards, apparently in severe pain. A good explanation is not, however, forthcoming. The opinion universally accepted by natives is that young juár, when suffering from deficiency of rain, becomes infested with an insect called *bhaunri*, to which its poisonous effect on cattle is due. Immediately rain falls the insect is said to perish, and unless the ears have appeared before the rain failed, the crop often recovers itself and yields a good outturn of grain."

The juár stalks were in a rotten condition when received in the Museum, but they were found to be tunnelled by a caterpillar, much in the way that sugarcane is tunnelled by the sugarcane-borer *Diatræa saccharalis* (see p. 22). The remains of the caterpillar, chrysalis, and imago of a small moth were also found amongst the stalks, but they were all in much too bad condition to determine definitely : as far as could be made out, however, they were very similar to the sugarcane-borer. In this connection it may be noticed that the sugarcane insect occurs in dry weather, the plants recovering, if not already too far gone when rain falls, just as Duthie and Fuller describe to be the case with the juár plants. The sugarcane-borer sets up putrefaction in the sugarcane stalk, and it is not improbable but that the juár insect may have a similar effect on the juár stalks, thus rendering them hurtful to cattle. The matter would seem to be of considerable interest, it is hoped therefore that better specimens of the insect, in all stages of development, may be sent to the Museum for comparison with the sugarcane insect.

Since the above was written, further specimens of the affected *Sorghum* shoots have been received from Mr. Woodrow. These were found to be tunnelled, and the base of the top shoots had become rotten and infested with dipterous larvæ, precisely as is the case with sugarcane attacked by the borer moth. On comparing the boring caterpillars taken from the *Sorghum* shoots with spirit specimens of the larvæ of the sugarcane moth, the two were found very similar in general size, coloration, and markings ; there were, however, a few minor points, in the markings, in which they were slightly different from each other.

[1] Received 24th December 1888.

This difference was not more than might be accounted for by individual variation in one species, but sufficiently long series of specimens of the two insects were not available to ascertain to what extent individual variation obtains in them.

In a large percentage of the tunnels the place of the boring caterpillar was found to be taken by several small silken cocoons of a chalcid fly which, no doubt, had destroyed the caterpillar; from the frequency of its occurrence in the shoots examined, this parasite seems likely to have a considerable effect in reducing the numbers of the pest.

Two live caterpillars were obtained from the *Sorghum* shoots. These were immediately transferred to sugarcane shoots to endeavour to rear them; they both burrowed eagerly into the sugarcane and appeared to thrive there; one of them, however, has since fallen a victim to the chalcid parasite whose eggs it must previously have harboured, but the second caterpillar is thriving,[1] and may yet turn into a moth, from which the identity of the species can be definitely determined. Some of the chalcid parasites are also being reared for a like purpose.

4.—A CATERPILLAR INJURIOUS TO TEA AND SÂL.

Dasychira thwaitesii, Moore.

Plate III, fig. 1, a *imago* ♀, b *imago* ♂, c *cocoon in tea leaf*, d *pupa*, e *larva* (*dorsal view*), f *larva* (*side view*), *all natural size; fig. 1*, g *Chalcis euplœa*, Hope (*enlarged*); *fig. 1*, h *Perilampus, new species* (*enlarged*).

Nature and extent of the damage.

Caterpillars and cocoons of this insect were forwarded to the Museum in February 1888 by Mr. Trotman of the Planters' Stores Agency, who writes—the caterpillars "have lately visited our Eastern Dooars tea garden in such quantities as to cause serious damage to the leaf of the tea shrubs."

In the *Indian Forester*[2] is an account by Mr. W. R. Fisher of a caterpillar that defoliated sâl trees in the Eastern Dooars and Goalpara in 1878, and which appears to be the same insect.

Mr. Fisher writes that, in the commencement of October 1878, every leaf of the sâl trees, in a forest of about two hundred square miles in extent, had been devoured. In this tract, which is situated on a raised plateau of red loam and gravel, and is called the Purbotjuar and Guma forests, and in which sâl almost everywhere constitutes the predominant species, the foliage was so completely destroyed that the sâl trees were rendered perfectly bare of leaves, and the ground was strewed with their débris, and with the caterpillar's dung.

[1] It afterwards transformed into a pupa and was apparently healthy until accidentally injured, in transferring it to fresh sugarcane. It is hoped that the next attempt to rear the moth, may be more successful. The chalcid parasite has been successfully reared and will be sent to Europe for precise determination.

[2] Vol. VI, p. 243, (1881).

The caterpillars, however, prevailed over a much larger area, the more westerly forests in the plains of the Eastern Dooars suffering the most. Other trees were also attacked, especially *Careya arborea*, and even the tea plants of a garden which had lately been opened out in the neighbourhood of the forest. From some of the villagers Mr. Fisher also learnt that there had been similar attacks of caterpillars within their memory.

Mr. Fisher observed that a large portion of the Sidli forests escaped damage, and that elsewhere patches where the forest growth was densest and finest, and probably the soil and air dampest, had also escaped, while in forests of more scattered growth, and where trees had been damaged by jungle fires, the leaves were all stripped off. This, Mr. Fisher thinks, may perhaps have been due to the inability of the caterpillar to feed upon leaves full of strong acrid juice which would be found in the more vigorous portions of the forest.

The insect, and its life history.

The insect belongs to the Bombyces moths of the family Liparidæ and has been described[1] by Mr. Moore as *Dasychira thwaitesii*.

The caterpillars, when full-fed, are about $1\frac{1}{4}$ to 2 inches long, covered all over with long, erect, yellow hairs, a thick bunch of which occurs on the dorsal aspect of each of the first four segments of the abdomen, and also on the terminal segment; there is a black transverse stripe between the two anterior dorsal tufts.

After it is full-fed the caterpillar spins itself up between the leaves of its food-plant, into a scanty cocoon, composed of its own hairs, which appear to be very easily detached, and which it binds together with silk. After almost completely denuding itself of hairs to form the cocoon in which it encloses itself, the caterpillar creeps out of its larval skin and becomes a pupa. In the case of the February generation, which was the one that was kept under observation, the insect remained in the pupal state for rather less than a fortnight. The most noticeable feature about the moth is the difference between the sexes, the male being very much smaller and more brightly coloured than the female.

Mr. Moore describes the moth as follows:—

"*Male:* fore wing, greyish white, crossed by a basal, antemedial, and a post medial, indistinct, black speckled sinuous duplex line, and a marginal side line, a lunular mark at the end of the cell, the lines slightly dilated at the costal end; hind wing, pale brown, the costal border and the cilia, greyish-white; thorax, head, palpi and legs, greyish-white; abdomen, pale brown; thorax, slightly brown speckled; sides of head and palpi, blackish, legs with black spots; antennæ ochreous brown, shaft white.

"*Female:* fore wing greyish-white, irrorated with numerous brown scales, the transverse sinuous lines much less defined, being mostly apparent at the costal end and composed of scattered brown scales; hind wing white, with a few brown scales from

[1] Lepidoptera, Ceylon, Vol. II, p. 98.

the anal angle; body greyish-white; thorax brown speckled; legs and antennæ as in the male.

"*Expanse*—male $1\frac{1}{2}$ inches; female $2\frac{3}{4}$ inches."

Food-plants; Moore quotes from Thwaites that the larvæ feed on *Erythrina indica*, while from the above we learn that it also feeds on tea, sâl, and *Careya arborea*.

Parasites.

A considerable number of cocoons were sent to the Museum, but almost all of them were destroyed by parasites, of which the most numerous in individuals was a tachinid fly. The pupæ of the tachinid were found in great numbers loose in the bottom of the breeding cage, where the larvæ, after leaving the caterpillars in which they had developed, had no doubt been overtaken by their pupal stage, whilst endeavouring to hide themselves in the ground after the manner of the "silk worm fly" with which they appear to be identical. A few chalcid parasites also emerged, and these Mr. P. Cameron has kindly examined: he finds that they belong to two species, *viz.*, *Chalcis* (*Brachymeria*) *euplœa*, and a new species of *Perilampus*. Of these three species of parasites, the tachinid flies, no doubt, did by far the most execution; but the chalcids must have accounted for a certain number of the pest, and altogether the parasites were so effective that out of a very considerable number of cocoons of the pest, which the writer attempted to rear, it was with difficulty that sufficient moths could be obtained for the identification of the species. If, therefore, the specimens sent to the Museum were at all representative of those left on the bushes, but very few moths of the February generation will have emerged to propagate the species, and there can be little to fear from the pest next year.

Dasychira thwaitesii seems to be singularly subject to the attack of parasites, for Mr. Fisher's experience in 1878 with the sâl pest is almost identical with what has been above described, in the case of the tea pest.

Mr. Fisher writes:[1]—

"I collected several hundred chrysalids, intending to send specimens for identification, but they all died, whether from a disease or ichneumons I cannot now determine. Since May 1879 I have not noticed a single specimen of the insect."

He considers that the mortality amongst the chrysalids may possibly have been due to the unusual heat and dryness of the weather in March and April 1879, but the writer is inclined to think that *Dasychira thwaitesii*, like many other insects, is continually kept in check by internal parasites, which have such vast powers of reproduction that, whenever their favourite food becomes abundant they multiply to such extent as very rapidly to destroy the great majority of the insects on which they feed, though they may never succeed in entirely extirpating them.

[1] *Indian Forester*, l. c.

The tachinid fly has not been described in this paper, as a considerable amount of information has been collected concerning it, and it would seem more appropriate to consider it in connection with the silk worm of which it is so serious a parasite.

The following is the synonymy, as given by Mr. P. Cameron, of *Chalcis euplœa*, the Hymenopterus parasite, with incrassated hind femora :—

"*Chalcis* (*Brachymeria*) *euplœa*, Westw., Proc. Ent. Soc. Lond., Vol. II, p. VI, Pl. II, figs. 9 and 10, (1837-40).

"*Chalcis lasus*, Walker, Ent. I, p. 219.

"*Chalcis inclinator*, Walker, Trans. Ent. Soc. Lond. (3), I, p. 355, (1862-64).

"*Chalcis obscurata*, Walker, Trans. Ent. Soc. Lond., 1874, p. 399. Exhibited by Hope at a meeting of the London Entomological Society as a parasite of a Euplœa butterfly from India.

"It is also recorded from Ceylon, Java, Aru, Borneo, Batchian, China and Japan."

The following is a translation of Westwood's description of the insect :—

"*Chalcis* (*Brachymeria*) *euplœa ;* Black, pubescent; thorax and head punctated, abdomen smooth ; tegulæ yellow; the two anterior pairs of legs yellow, except the femora, which in the front legs are black at the base, and in the second pair of legs are black with yellow extremities ; in the hind legs, the coxa, and trochanter are black the femur is black, with yellow on both sides of the extremity ; the tibia is yellow except at the base where it is blackish ; the tarsi are yellow, and the pulvillous yellow. The posterior femora are each armed, on the internal margin, with about ten minute teeth."

From the descriptions given by Walker and Westwood, it appears that the length of the body varies from two to three lines, the expanse of the wings from $3\frac{1}{2}$ to 5 lines.

The second chalcid, which Mr. Cameron has determined as a new species of *Perilampus*, is figured in the plate, but has not yet been described.

Remedies.

If it should turn out, as now appears probable, that the tachinid which attacks the *Dasychira thwaitesii* is the same as the "fly" that destroys silk worms in Murshidabad and other parts of Bengal, it would seem to be well worth while to ascertain by actual experiment whether the increase of the pest cannot be more rapidly controlled by introducing fly-blown worms from the silk districts than by waiting for the parasites to be introduced by accident.

Besides any such possible method of controlling the pest, however, there can be no doubt but that, in any limited area, the caterpillars can be readily destroyed by arsenical insecticides,[1] though it has yet to be ascertained to what extent it will pay to employ these substances in India.

[1] See Notes on Economic Entomology, No. 2.

The fact, observed by Mr. Fisher, that vigorous trees are not attacked to the same extent as trees in an unhealthy condition, is worthy of notice as being another instance of what would seem to be a very general law with insect pests.

5.—CUT WORMS.

Agrotis suffusa, Hübn.

Plate III, fig. 2, a *larva* (*nat. size*), b *larval head* (*enlarged*), c *moth* (*nat. size*).

Injury to paddy from insects that are probably "Cut worms" has been reported from Balasore and Chittagong, while it is not improbable that much of the damage reported from other districts as due to obscure lepidopterous larvæ, may also have been doneby insects belonging to this group.

The following abstract therefore is given of an account by Dr. Riley of the general habits of Cut Worms in America, together with his suggestion for dealing with them :—

"Cut Worms are Noctuid moths, generally belonging to the general *Agrotis, Hadena* and *Mamestra*. The larvæ are stout, naked worms of sombre colours, curling into a roll when disturbed and transforming to naked pupæ under ground. The moths fly only at night or in the dusk ; they generally attach their eggs near the ground on twigs and branches of trees *away* from the food of the young larvæ, which have therefore to seek their food-plant when they hatch out. In their first larval stages the larvæ are much like loopers (Geometrites) ; at the approach of winter (in the North States of America) they are generally about half-grown and hybernate under stones and logs, or burrow beneath the surface of the ground. From these winter quarters they come forth on the approach of spring and do great injury to young and tender plants, not contenting themselves with feeding on leaves but cutting off the plants at their stems. Many feed by day, as well as by night, pulling leaves and sprouts into the underground burrows and there devouring them at their leisure. The pupal state, which is passed underground, lasts three or four weeks. Many of the species are one-brooded in the United States, but others have two broods. The larvæ are attacked by Tachinid and Ichneumon parasites."

Remedies.

The following has been found effectual by Dr. Riley for destroying Cut worms. Bundles of cabbage, turnip, or clover are sprinkled with Paris green water and laid at intervals between the rows of the crop to be protected, but, before the plants come up, these poison the Cut worms, which are thus got rid of before the appearance of the crop which they would otherwise attack.

Agrotis suffusa.

In the Museum collection is a specimen of the Noctues moth *Agrotis suffusa*, bred by Mr. Wood-Mason in September 1887 from a caterpillar that was said to attack the winter crops, mustard and linseed, in the Jessore district.

This, a cosmopolitan insect, which has been recorded as occurring in all parts of India, besides Ceylon, Europe, America, Australia, New Zealand, Africa and China.

Dr. Riley, in Report of the United States *Entomologist* for 1884, page 294, describes it as *Agrotis ypsilon* or the "Greasy Cut Worm," having previously described it in the *Prairie Farmer*, June 2nd 1867, as the "Black Cut Worm;" and in the first report of the insects of Missouri, 1869, page 80, as *Agrotis telifera* of Harris, while the insect has been described in Europe by Van Rottenburg as *ypsilon*, and by Hübner as *suffusa*. Of all the names, however, by which this insect has been called, *Agrotis suffusa*[1] seems to be the best known, and it is therefore adopted here.

Dr. Riley writes[2]:—

"The larva has a most emphatic and pernicious cutting habit. We have known it cut off large tomato plants that were over six inches in height, generally at an inch above ground. After severing one plant, the same worm would travel to other plants, and thus, in a single night, would ruin three or four. In quite hard, clayey, corn-land, each worm was found to have a smooth burrow, in which it lay hidden during the day, and to the bottom of which it could generally be traced.

"Nothing seems to come amiss to its voracious appetite. It is reported as one of the species especially destructive to corn-fields and gardens. It destroys young tomato and tobacco plants, and, in confinement, feeds with equal relish on apple and grape leaves, and has been found in a garden cutting off cypress vines; it is also one of the cotton Cut worms of the south."

Dr. Riley notices that there are probably two generations of the insect in the year, and that there is great irregularity in the time of development and mode of hybernation:—

"The eggs are laid in small batches, and often in two or three layers, covered sparsely with long scales from the abdomen of the female moth. They are pale fulvous in colour, and nearly spherical in shape, the base being somewhat flattened. The polar ribs are not very distinct and the crown is small. These eggs we have found laid on peach and sycamore leaves, upon which the larvæ do not feed. The larva in the first stage is also a semi-looper, the front prolegs being atrophied. The species is parasitized by tachinidæ, which we have often bred from it."

[1] See "Catalogue of the Moths of India," Cotes and Swinhoe, page 309, for further references to what has been written on this insect.

[2] Report of U. S. Entomologist, 1884, page 294.

[3] Riley, *l. c.*

6.—THE CEDRELA TOONA MOTH.

Magiria robusta, Moore.

Plate III, fig. 3, a moth, b pupa, c larva; all natural size.

Specimens of this pest have been received from Mr. E. E. Green, of Ceylon, who writes that the larvæ damage *Cedrela toona* trees which are cultivated on the coffee estates for firewood and timber-supply.

Mr. Green writes [1] :—

"The larvæ appear to affect the new growth only, living on the succulent tops and devouring the pith of the stems and leaf stalks. The effect of the borer is to kill off the leading shoot, after which numerous adventitious shoots appear below the point of injury. The presence of the borer may be detected by the accumulation of the excreta at the mouth of the tunnel where they are fixed and woven together with silk by the larva."

The following extract is taken from a paper [2] signed T. S. G. that appeared in the *Indian Forester* in 1876, and which appears to apply to the same species :—

"The insect almost yearly attacks the young shoots of the toon tree, boring its way along the pith which it seems to live upon, and leaving behind it an unsightly looking mass of transparent gummy exudation. The larvæ is white with black and yellow spots. ..... It attacks trees both in plantations and in the forests, and prefers those about three feet in height and of strong growth. It seems to attack, however, more particularly those trees which grow in cleared land or near roads, while others growing close by, in grass or with other trees, have been comparatively unharmed."

Some larvæ of this insect have been sent to the Museum by the Sub-divisional Officer of Alipur, Western Dooars, who found them in the wood of some young mahogany trees. In this case, however, it seems probable that most of the injury was done by some Coleopterous larvæ that were also found in considerable numbers.

Mr. Moore, in his Lepidoptera of Ceylon, Vol. III, p. 366, quotes from Thwaites that the larvæ feed within the branchlets of mahogany.

From the Director of the Forest School, Dehra Dun, have been received specimens of what appears to be the caterpillar of this moth, found by the Forest Ranger of Nilambur, Madras, "attacking the succulent branches of experimental mahogany plants."

Caterpillars of this insect were also obtained from the Museum of the Forest School, Dehra Dun, where they were marked as having, in June 1886, proved destructive to the seeds [3] of *Cedrela toona*.

Mr. Moore, in his Lepidoptera of Ceylon, classes the insect in the family Phycitidæ.

The following is his description :—

"Female. Fore wing, pale ochreous-brown, very thickly speckled with cinereous-white along the anterior border, and sparsely speckled with black scales along the

[1] Letter dated 7th January 1889. [2] *Indian Forester*, Vol. I, p. 197 (1876).
[3] This may possibly be a mistake.

posterior border; all the veins, excepting the submedian, lined with black, crossed by a discal, denticulated, whitish-speckled line; marginal points white; hind wing, ochreous-white, semi-hyaline, slightly opalescent, with a pale ochreous-brown slender marginal border; cilia white, with a brown inner line. Body, palpi and legs ochreous-brown; sides of collar, tegulæ, and base of abdomen with a cluster of black speckles; fore legs above dark-brown, with white bands; middle and hind legs whitish speckled a brown band on middle tibiæ, and whitish bands on the tarsi. Expanse of the female one and three-tenths of an inch."

"Pupa dark purple-brown, enclosed within an elongated slight silken cocoon attached to the stem of the food-plant."

Mr. Green describes the larva as follows :—

"Colour dull purple. Head black—second and thirteenth segments each with two black corneous dorsal plates. Other segments each with a transverse series of six raised black corneous spots, with a second row of two similar spots on each of the fifth to the twelfth segments. A small dull orange-coloured lateral spot on second and fifth to twelfth segments. Spins a compact whitish cocoon."

The larvæ reared by Mr. Green were full fed about the end of September, the moths appearing towards the end of October.

7.—CLOTHES MOTHS.

Blanket moth.

Specimens of a Clothes moth, and of blankets destroyed by it, were received in December 1887 from the Superintendent and Agent, Army Clothing, Alipore, with the information that they were taken from a bale of country blanketing which had been baled up and 'dammered' about two years previously, and which was found to be completely destroyed. It was also stated that it was impossible to open such bales periodically for brushing and beating.

Amongst the débris we found a few larvæ, mostly in the earlier stages of development, and a large number of empty, paper-like cocoons of a Tineid moth most nearly resembling Taschenberg's description (Praktische insektenkunde, Vol. III, 1880, p. 261) of *Tineola baseliella* Humm. which is known to attack woollen cloth, feathers, and such like.

Specimens of the moth were successfully reared in the Museum and forwarded to Europe for precise determination, but they have not yet been returned.

It was suggested that a little kerosine oil poured into the centre of a bale before closing it up would probably preserve it from attack, and that a weak solution of carbolic acid, spirits of turpentine, benzine, camphor, or naphthaline would also probably be effective, regard being had to their relative cost, and the offensiveness of the odour likely to remain in the articles composing the bale.

Since the above was written information[1] has been received from Mr. Wood-Mason that naphthaline, which is largely used in this Museum as

[1] In a letter, dated 7th January 1889.

a preservative against insects, has been repeatedly supplied to the Army Clothing Department, both for clothes and also blankets, and that it appears to have proved a success. Fears were at first entertained that the naphthaline would tarnish gold lace, but Mr. Wood-Mason has found that this is not the case.

Wool moth.

Specimens of Clothes Moth, a which is probably *Tinea tapetzella*, have been received from Mr. R. Chapman, with the information that they have done some damage to raw wool in the Economic section of this Museum.

8.—THE BENGAL RICE HISPA.

Hispa ænescens, Baly.

Plate II, fig. 1, a (*nat. size*), b (*enlarged*).

Distribution.

This rice pest is widely distributed in India, and a number of reports have been received of damage done by it in different parts of Bengal. In the collections of the Indian Museum, there are specimens from Sikkim (Atkinson), Kullu (purchased), Chittagong (Director of Land Records and Agriculture, Bengal), Midnapore (Cotton), Calcutta (Lyall, also from the Collector, 24-Pergunnahs), Khulna (Rainey), Durbhunga (Duff), Hooghly (Collector of the 24-Pergunnahs), Behar (Moulvi Syed Nisah Ali, through the Director of Land Records and Agriculture, Bengal), South India (Father Honoré).

Zoological position of the insect.

The insect is a beetle belonging to the family Chrysomelidæ, almost all the species of which feed on leaves, both in the larval state, and also after they have become beetles; by far the greater part of the damage, however, being done by the larvæ.

Life history.

From the reports that have been received, it seems that the pest appears often in vast numbers during the rains, when the rice has just been planted out and is still young and tender, the insects feeding on the parenchyma of the leaves and stalks, leaving the fibre exposed, so as to give the plants a white and withered appearance. The insect pupates on the plant.

Details of the life history of this pest are at present wanting, but it may be inferred from the life history of other species of Chrysomelidæ, which have been carefully studied in America and Europe, that the history of *Hispa ænescens* is somewhat as follows:—

The eggs are probably deposited on the leaves of the rice immediately after it is planted out, the young larvæ quickly emerging and proceeding to devour the tender leaves, the pupæ being formed on the plant, and the perfect beetle emerging within a fortnight or three weeks of the eggs being deposited: so that the cycle of a generation may be gone

through in the course of three weeks or a month, and several generations may occur in the year, the beetles assisting the larvæ in their work of destruction and finally hybernating, in any neighbouring shelter, in this stage.

As yet the beetle is the only stage in the insect's life of which specimens have been received, but it is hoped that next year some of the contributors to these "Notes on Economic Entomology" may interest themselves in procuring specimens in other stages of development (egg, larva and pupa), and also in studying its life history. Some of the most important points to observe being,—the number of generations gone through by the insect while it remains on the rice; the manner in which it passes its existence in the interval between disappearing in the autumn and being again seen in the rains; and last, but not least, the methods which are likely to be effectual in combating it.

Damage done by the pest.

The effect of the pest would seem to be to stunt and weaken the plants and cause them to yield but a small crop. The rice is apparently in no case completely destroyed by the insect, but the outturn may be reduced by from twelve to fifty per cent.

Remedies.

No very definite information has yet been received with regard to remedies: the only two that are mentioned as adopted by the cultivators, being the smoking the insects out of the field, and the letting out of the water.

With regard to the first of these remedies, Mr. F. W. Higgins, of Chittagong, writes[1]:—

"On my bearer informing me of its (*i.e.*, *Burmah chaudali*) having attacked his paddy, I advised him to try smoking them out, and he reported its having acted like a charm; in half an hour all had cleared off from the paddy. About four kamis were attacked out of ten kamis planted. The *modus operandi* was as follows:—Fires of paddy-straw, covered over with green leaves to increase the smoke, were placed about the field at about 30 to 40 feet apart (a calm day was selected). When the smoke had spread about a little, four men with torches of lighted paddy-straw, twisted up and slightly damped on the outside to increase the smoke, went through the paddy, shaking off the bugs and moving the smoking mass amongst the corn. The bugs cleared out entirely, but I cannot guarantee their having been destroyed."

The smoking operation does not seem to have been tried elsewhere on this pest, and as smoke has been found to be altogether ineffectual against other insect pests on which it has been tried, the writer is inclined to think that reliance should not be placed in the remedy until it has been more definitely tested.

With regard to the letting out of the water from the rice fields, as a remedy for the pest, mentioned in a report[2] by the Deputy Collector

[1] In a letter to the Collector of Chittagong, forwarded by the Director of Land Records and Agriculture, Bengal. See page 40.

[2] Forwarded by the Collector of the 24-Pergunnahs.

of Basirhat, this would appear to be more promising, though it would obviously be only possible to adopt it in certain cases. In this connection the Deputy Collector of Basirhat notices that only rice which is almost completely submerged is attacked, the attack lasting only so long as the water remains in the field, and the rice which grows where there is but little water being exempt.

Arsenical washes, such as London purple and Paris green, have been found useful in America for destroying the elm leaf beetle, which belongs to the same family as *Hispa ænescens*, and these preparations would no doubt be equally effective in destroying the Rice Hispa, but the cost of their application would seem likely to be prohibitive.

The following description of the beetle by Mr. Jacob S. Baly was published in the Journal, Asiatic Society of Bengal, Volume LV, Part II, page 412 (1886).

Hispa ænescens.

"*Subelongata, nitida, subtus cum antennis nigra, pedibus nigro-æneo micantibus; supra nigro-æneo aut nigro-cuprea; thorace rugoso-punctato, lateribus ante medium spinis quatuor, basi connatis et pone medium spinâ unicâ armatis; elytris anguste oblongis, fortiter seriato-punctatis, spinis validis triseriatim dispositis, instructis. Long. 2 lin.*

"Hab. Chittagong District.

"Antennæ slender, very slightly thickened towards the apex, the basal joint armed at its apex beneath with a short tooth; vertex finely rugulose, longitudinally sulcate. Thorax rather broader than long, subcylindrical, flattened on the disk; sides armed before the middle with four stout spines, united into a single stem at their base, the anterior spine looking almost directly upwards, the three others obliquely upwards and outwards; behind the middle is also a single spine, looking outwards and slightly upwards, hinder angle armed with a short subacute tooth; disk coarsely rugose-punctate, a longitudinal vitta and a slightly concave space on either side behind the middle nearly free from punctures. Scutellum smooth, impunctate. Elytra narrowly oblong, strongly seriate-punctate, armed with a number of strong erect spines, arranged in three longitudinal rows, those on the outer row more crowded than those on the disk. Legs simple.

"The small tooth at the lower edge of the apex of the basal joints of the antennæ, and the absence of any spines on the upper surface of the joints, together with the colour of the upper surface of the body, will separate the above species from any others known to me."

Correspondence concerning the Rice Hispa.

The Collector of Chittagong writes:—

"During[1] a tour in the district lately, I came across fields of aus dhan which had been destroyed by insects. In fact, the greater part of the aus crops in many mouzahs of this district had been thus destroyed. The insects attack the young dhan. It then withers and dies away, presenting the appearance as if it had been eaten up by goats or cows.

"I found that the aus dhan was attacked by two kinds of insects, one is known locally as the *Burmah chaudali*; it is a small black beetle.[2]

[1] In a letter dated 30th September 1886, which was forwarded by the Director of Land Records and Agriculture, Bengal.

[2] Specimens were sent, which proved to be *Hispa ænescens*.

"My attention was first drawn to these insects, and the ravages they made amongst the aus dhan, by Mr. F. W. Higgins, of Patya, a tea-planter of this district. The following is an extract from a letter on the subject written by that gentleman the other day to me. He writes chiefly about the *Burmah chaudali.*"

Here follows the extract quoted on page 38.

Mr. J. R. Rainey of Khulna notes[1] that the local native name of the insect is "*Paruli.*" He writes that it is "very destructive to the leaves of the paddy crop when the plant is young and tender." The rice stalks which he sends have the parenchyma of the leaves eaten away in patches, so as to make them look brown and withered.

Mr. Patrick Duff writes[2]:—

"I kept a few insects which did a great deal of harm this year to the dhan, but more particularly to the *ropa*, or transplanted paddy. They appeared late in June, and were very plentiful in July and the beginning of August. I send you a small box containing all the specimens I kept. Neither sun nor rain seemed to diminish their numbers. They are said to have been seen once before 16 or 17 years ago; some persons called them '*Kal*' and others '*Mudhwa.*' They devoured the tender case of the dhan and laid their eggs in the upper leaves, apparently inserting the egg under the outer fibre of the leaves; or perhaps the growing insects forced their way under the leaves, splitting them in two and staying inside until perfect. The ones I send were in the chrysalis state when I took them out of the leaves, and I placed them in a pill box. The effect of the ravages was only to temporarily check the growth of the dhan. It is now looking well again. One peculiarity I noticed was that the insects always attacked the western edge of the fields and worked eastwards. They were literally in millions in every field."

Baboo Doorga Churn Law, of Hooghly, notes that the insect is called *Sanki*:—he writes[3]: "Small circular insects of black color; three or four of these enter the stalk and cut it. It is very destructive to paddy and remains long in the field."

Baboo Nobin Krishna Banerji of Diamond Harbour writes:[4] "*Paruli* insects are not available this year in consequence of flood. The ryots cannot give any information as to how these insects are bred."

Mr. F. J. S. Maguire writes[5]:—

"The sub-divisional officer of Bagirhat, and the Naib of Chandkhali (a Government estate), report that it does not appear that there has been any occurrence of insect pests. Both these officers report that *Pavali poka* damages to a certain extent the rice crop. Damage is done by them both at the time of transplantation and at the time when the rice is about to be reaped."

[1] In a letter dated 12th July.

[2] In a letter dated 6th September from Bhuptiabe, forwarded by the Magistrate of Durbhanga.

[3] In a letter dated 26th September 1888, forwarded by the Collector of the 24-Pergunnahs.

[4] In a letter dated 1st October, forwarded by the Collector of the 24-Pergunnahs.

[5] In a letter dated 25th September, forwarded by the Director of Land Records and Agriculture, Bengal.

Baboo Mohendra Nath Bose writes [1] of *Hispa ænescens* that it is called *Pâmâri*—"These insects always exist in the paddy fields, and probably grow in earth, when in the middle of the month of Aswin, corresponding to the months of September and October, western winds blow very hard, these insects fly out in the air in innumerable number and destroy the paddy plants."

The Sub-Manager of the Raj, Darbhunga, wrote [2] of *Hispa ænescens* on 11th October—"A peculiar kind of black insect that has been eating away wholesale the green leaves of the paddy in almost all the villages in my circle. The ryots say that they never saw such insect pests before."

On 31st October the Manager of the Raj, Darbhunga, wrote [3]: "These pests have now nearly disappeared."

The following is an abstract of a report [4] by the Deputy Collector of Basirhat:—

"*Shanki poka*, or 'the Whitening Insect,' is a small, black, fly-like insect which damages the young paddy plants, and especially of *amun* rice. The insect eats off the green covering of the leaves, leaving the fibre intact, which gives the paddy a white and withered appearance. The young plants are weakened and stunted in growth by the attack, and consequently yield from twelve to fifty per cent. less than they otherwise would do, but the crop is never totally destroyed. The pest is first noticed in June or July when it appears in such vast numbers as sometimes to blacken square miles of rice fields. It attacks the seedlings which have only just taken root after transplantation, and of these only such as are almost completely submerged in the water, paddy which stands on ground where there is but little water being exempt: again, for seedlings to be attacked, they must be in the first stage of their growth, when the leaves are young and tender, before they become rough and hard and their edges become sharp, as in the second stage of growth when the pest is unable to harm them. The pest selects, in the first instance, the fresh green shoots, and, after eating these, it attacks such of the older leaves as are still somewhat soft and, thin; in the case of the older leaves, however, it only eats the parenchyma, leaving the fibre exposed; the pest also devours each fresh blade as it is put forth.

"The attack lasts as long as the water remains in the field, the insects disappearing altogether for the season as soon as the water subsides sufficiently to expose the paddy stalks.

"The only thing ever done by the cultivators to fight the pest is to let the water out of the field, and this of course can only be effected in some cases.

"A curious superstition prevails with regard to the insect, and is entirely believed in by the cultivators. The notion being that the surest way to get rid of the pest, is for a man or boy who has been born in the month of Bhadro, to walk over the field and stick a leaf of a date tree in some part of it, then to pinch off the heads of some of the insects and bury the headless bodies in the field. The superstition has so strong a hold on the minds of the cultivators that whenever the pest appears they invariably (and sometimes at great expense) seek out a Bhadro-born man or boy and get them to perform the ceremony. This pest is said to occur more frequently than the jute pest, but no [5] specimens could be found for the Deputy Collector of Basirhat to forward.

[1] In a letter dated Calcutta, 2nd September 1888, forwarded by the Collector of 24-Pergunnahs.

[2] In a letter dated 11th October, forwarded by the Magistrate of Durbhanga.

[3] In a letter dated 31st October, forwarded by the Magistrate of Durbhanga.

[4] Dated 5th November, and forwarded by the Collector of the 24-Pergunnahs.

[5] Specimens of *Hispa ænescens* from the Museum, however, were sent to the Deputy Collector of Basirhat, who identified them as the "*Shanki poka.*"

9. THE MAKAI TREE BARK BORER.

Tomicus sp .

Specimens of a Scolytid beetle, reported by the Officiating Deputy Conservator of Forests, Sibsagar, Assam, to be injurious to the Makai tree, *Shorea assamica*, have been received through the Director of the Forest School, Dehra Dun.

The insect proves on examination to be a bark beetle belonging to the genus Tomicus (family Scolytidæ). It has not been found possible to determine it with absolute certainty in this Museum, and specimens have therefore been sent to Europe for comparison :[1] the insect, however, corresponds very closely to the description of *Tomicus chalcographus* of Linnæus, an insect recorded as injurious to *Abies excelsa* and other trees throughout the whole of Europe and also in America.[2] An excellent description of the insect is given in Eichhoff's "Europäischen Borkenkäfer"—Berlin, 1881, p. 249 ; his remarks, however, are not given here in full, as the identity of the insect has not yet been fully established.

In this group of insects the female beetle bores its way into the bark, thus making a tunnel, along the sides of which it deposits its eggs. The grubs on emerging from the eggs, each tunnels on its own account from the place where its egg-shell lay, becomes full-fed, and transforms into a pupa in the burrow, emerging as a beetle which copulates and lays its eggs. The beetle is known to prefer for its attack, trees whose vitality is impaired, and in which therefore the flow of sap is not very strong. Eichhoff has observed, in the case of *Tomicus curvidens* (and he believes it to be also the case with *T. chalcographus*), that, when it is unable to find damaged trees, it attacks healthy ones, tunnelling in great numbers into them and thus lowering their vitality and making them suitable for the nourishment of the species. It is true that the flow of sap in the tree may be too strong for the eggs of the actual beetles that first attack it to come to anything, but the tree is so injured that it falls an easy prey to succeeding generations of the pest which emerge from other trees which are in a more advanced stage of the attack.

Eichhoff has observed in Germany that the beetles emerge in great numbers in April or May ; copulate and lay their eggs, which become fully developed in the end of June or in July, when the second generation of beetles emerges to copulate and lay eggs, becoming fully developed in the autumn and emerging the following April or May. There are thus two complete generations gone through by the insect in Europe,

[1] Specimens of this insect were submitted to Dr. Günther, who had kindly undertaken to have them examined. He has since reported on them as belonging to a species of *Tomicus*, which is unnamed in the collections of the British Museum.

[2] For an account of the insect in America, see Packard, U. S. Ent. Commission, Bull. No. 7, 1881, p. 166.

and it is probable that, with increased warmth, this number may be exceeded in India.

From the habits of the insect, preventive measures have been devised which Eichhoff recommends very strongly, and which have certainly been adopted in some parts of Germany, though it remains to be seen to what extent they are applicable in India.

The following are the measures which Eichhoff recommends (see his Europäischen Borkenkäfer, p. 228).

All damaged and unhealthy trees should be, as far as possible, removed or barked, as it is in these that the beetle chiefly breeds. Unbarked trees should not be allowed to lie about in the forest. Traps should be prepared periodically for the insects, at the times that the insects are known to be on the wing, by felling or ringing a certain number of trees, and leaving them in a withering condition in the forest during the two or three weeks the insects are about. Most attractive food will thus be provided for the beetles, which will lay their eggs in vast numbers in the prepared trees and spare the healthy ones, which they would otherwise attack. After the prepared trees have remained for three or four weeks in a withering condition in the forest, they should be carefully barked, and the bark and branches burnt, so as to destroy the grubs of the bark beetles, which would otherwise emerge as beetles about two months after the eggs had been laid.

The beetles sent to the Museum were forwarded from Assam on the 4th of April last year; it may therefore be presumed that about that date, or shortly afterwards, they would have emerged, and have commenced laying their eggs. The end of March would therefore be the time to prepare trees to entrap the first generation of the insect, while the following generations might be expected to emerge respectively in June, August and October; about the number and dates of emergence of the respective generations, however, no information has been obtained.

It would be well worth, in observing the general life history of the insect in India, to direct particular attention to the number of generations in the year, and the dates of their respective emergence; and, having done this, to ascertain by careful experiment whether or not Eichhoff's recommendations are likely to be of service.

10. BAMBOO INSECT.

Mr. G. Anderson, of Munzerabad, Mysore, sends pieces of jungle wood [1] attacked by an insect locally known as "Cootee.[2]" He writes:—

"This class destroys bamboos, watties (basket-reeds), and many jungle woods. The natives have a superstition that no jungle poles or bamboos should be cut when the moon is full, as they argue that the sap is then very abundant, and unless the

[1] "Probably *Erinocarpus nimmoanus*." See his letter dated Barguai, 21st April 1888.

[2] A Canarese word, *ibid.*

bamboos are well soaked in a tank and subsequently preserved with plenty of smoke they will be rapidly destroyed by the *cootee* and other borers. The advice is excellent and should be invariably adopted, but it would be interesting to know what actual effect the moon has on the motion of the sap in growing trees. These insects also attack the pod, or capsule, of cardamoms, and, I think, are propagated in the forest rubbish; but the fact that I have found the insect in the larval and perfect state inside the capsule, suggests the probability that the female punctures the outer skin, lays its eggs therein, and the grubs, having passed the pupal stage, emerge as perfect beetles by the small round hole, leaving the cardamoms perfectly empty. 'Cotee' also attacks horse and cow-gram (*Dolichos inflorus* and *lablab*) and will utterly destroy solah pith hats, bread, baskets, mats, &c."

The insects which Mr. Anderson sends belong to a species of Bostrychidæ Beetles (Apatides), which, however, it has not been possible to identify precisely in Calcutta; specimens have therefore been sent to Europe for comparison.[1] It may be observed that all the substances which Mr. Anderson mentions, are not likely to be attacked by the same species, though they may be attacked by species which are very nearly allied to each other. The idea which prevails with regard to the effect of the moon is a curious one, and would really seem to have some foundation of fact to rest upon, the writer having been told that it prevails generally, both in Behar and also in the North-West. About the only explanation that has been put forward is to the effect that the 'cootee,' like most other wood-boring insects, prefers to lay its eggs in wood which has commenced to wither, and which consequently has no longer a healthy flow of sap to interfere with the insect in its burrow, though still full of nutritive juices on which the insect feeds. If this is the case, the time immediately after the bamboo has been cut down would be the most likely one for it to be attacked; and moonlight nights would give the insect a quiet time, with plenty of light, for finding the bamboos and ovipositing in them. This explanation, however, is little more than a guess and requires confirmation.

It seems to be the generally received idea that soaking bamboos, and also other timber, in water, for a considerable time, immediately after it has been felled, makes it less liable, than it otherwise would be, to suffer from boring beetles of all kinds. It is supposed that not only does the water prevent the beetles laying their eggs during the time the wood is immersed in it, but that it also drowns the larvæ already at work, and dissolves much of the nutritive matter on which they would otherwise feed.

It is notorious that bamboos suffer very considerably from the attack of small boring Bostrychid (Apatid) beetles. The writer has found

[1] Specimens of this insect were submitted to Dr. Günther, who had kindly undertaken to have them examined. He has since reported on them as belonging to a species of *Sinoxylon* which is unnamed in the collections of the British Museum. He also reports on a second species that was obtained by Mr. R. D. Oldham, in Dehra Dun, from a tent pole, which it had completely destroyed, as belonging to a species of *Dinoderus*, not in the British Museum collection.

that sponging the bamboo over with kerosine, in sufficient quantity to penetrate into their burrows, destroys the insects effectively and prevents further damage. This treatment, however, is obviously only applicable in a limited number of cases.

11. THE MANGO WEEVIL.

(*Cryptorhynchus mangifera*).

Plate IV, fig. I, a *larva,* b *pupa,* c *imago (dorsal view),* d *imago, ventral view: all enlarged.*

An Extract.[1]

The mango weevil would be classified as follows:—Order *Coleoptera;* family *Curculionidæ;* genus *Cryptorhynchus;* species *mangifera* (of Fabricius). The specimen from which my slides were taken was a little over $\frac{1}{4}$ of an inch in length, and about $\frac{1}{8}$ of an inch in breadth; and to ensure identity, was taken by me fresh from the heart of the fruit. Almost black when first removed from the mango, on being dried it assumed a lighter, rusty-brown hue. The head of the weevil is produced into a rostrum, with ten jointed antennæ on its sides, which are elbowed beyond the long scape, and terminate in a knob.

The elytra are very convex, and extremely hard; and, together with the rostrum and feet, are covered with scales of a light yellowish colour; these scales are not brilliant.

The larvæ answer the general description of larvæ in the weevil family; they were white, "thick, fleshy, footless grubs, with fleshy tubercles instead of legs" (Packard, p. 484), and while there were three or four of them together in one mango, I have not found more than one pupa, or one perfect insect in any single fruit. The larval and pupa stages are passed, and the imago form attained in the fruit itself; and the period of pupation would seem to be short, seeing the larvæ were obtained from a ripe mango.

The geographical range of the pest under consideration is extensive. It is found in the Isle of France and in Madagascar, and it would be interesting to learn something about its ravages, and to ascertain when it was first observed, how supposed to be introduced, &c., in the islands named. It does not yet affect all the mango-producing districts of India, but its march is progressive. Restricted apparently at one time to Dacca and the South-Eastern districts, Backergunge, Furridpore, &c., I learn it is working its way westward and northward, and throughout Bengal and the neighbouring districts. An article on the subject will be found at page 558 of *Reis and Rayyet* for 1885, in which we are told that this insect-pest has invaded the Presidency, and that in the season

[1] Taken from a paper by Mr. W. J. Simmons in the Journal of the Agricultural and Horticultural Society of India, Volume VIII, Part II, new series.

of 1885 it showed itself in the well-kept orchard of Kaly Kissen Tagore. I learn from a gentleman residing in Ballygunge that every tree in his garden is infected. *Reis and Rayyet* also informs us that Sylhet was formerly practically free from this curculio, two or three mangoes per 1,000 alone being tainted. During the last few years the pest has gained ground so rapidly in Sylhet that now not a single tree nor fruit is free. According to Tayler's Thirty-eight Years in India (Volume II, page 331) the mango is the staple fruit of India, and millions almost subsist on it during the season. Roxburgh says that in times of great scarcity and famine, the kernels are boiled in the steam of water and eaten. When you remember, from your own personal observation, how largely the mango enters into the dietary of the poorer classes, you will readily realize that the depredations of the weevil which attacks it are a serious matter.

I expect the egg of the weevil is deposited either in the flower, or in the very young fruit. During the last mango season—which, by the way, was not prolific in weevils—I examined several specimens of the fruit with the view of ascertaining what external indication they bore of the existence of the insect within, and I failed to "see it from the outside," as one of the papers I have referred to says it can be seen. In almost every case examined by me, the weevil was about one-third off from the further end of the drupe, while there were no indications of its having worked its way from the surface, or the stem, through the pulp, to the cell. The cells were usually filled with brownish granules which I took to be the excreta of the insect.

The insect is found in the adult phase of its existence in the months of May, June, and July. The mango tree blossoms at the close of the cold season. Unless, therefore, there are two broods of the curculio, which is not likely to be the case, the pest must live through the drenching rains of the rainy season, and the low temperature prevailing in the cold months; and whether it attacks the flower, or the young fruit, it must be in a fit condition when the mango trees blossom, or their young fruits form, to deposit its ova. Now, we know that many insects pass from one season to another in a state of hybernation. They may hybernate in either the larva, or the pupa, or the adult state; or again they may lie over in the egg. I doubt very much if the eggs of the mango curculio are laid in the season previous to their being hatched; I think it probable that the *imago*, or adult weevil, lives over from one season to the next, and that in the interval it hides away in crevices under the bark, or in rubbish, or the like. In this connection, it is perhaps of some importance to note that if it hybernates in the localities I have suggested, then the dingy colour of this curculio is distinctly protective. Anyhow all these are matters which can only be verified by actual observation.

12.—DERMESTES VULPINUS, Fabr.[1]

Plate IV, fig. 2, a *larva* (*dorsal view*), b *larva* (*side view*), c *pupa*, d *imago ; all enlarged ; fig. 2,* e *imago* (*nat. size*).

Some specimens of *Dermestes vulpinus*, the leather beetle of America, have recently been sent to the Indian Museum by Mr. J. Cleghorn, of Rajshahye, who says that the larvæ attack eggs, worms, chrysalids and moths of the mulberry silkworm. During the rains cocoons having often to be reeled off, on account of damage done by this insect, within a fortnight of having been received, instead of being allowed to ripen as in the hot weather. The cocoons are thereby depreciated in value, sometimes to the extent of ₹12 per maund. Mr. Cleghorn has observed that the insects are most abundant during the rains, their numbers diminishing during the months between October and May, though causing loss of produce even during these months. He has seen the beetles flying at dusk into the house, and making straight for where cocoons are stored, selecting, in the first instance, ones that contain putrefying chrysalids, but also attacking sound ones; he has also found large numbers of the beetles drowned in water containing putrid matter.

The larvæ work their way readily through the substance of the silk cocoon to get at the enclosed chrysalid which they devour, and appear to thrive indifferently on any animal matter, having taken with much relish to a series of dead insects with which they have been fed in the Museum.

In the Indian Museum collections are imagos of this species from the Hazaribagh district (Wood-Mason), where they are said to attack stored tusser cocoons, also from Calcutta, Madras (Elliot), Naga Hills (Godwin-Austen), Deccan (Sykes), Bhutan (Pemberton), Muscat (Blanford), Nicobar Islands (de Roepstorff), South Australia (Wilson) New Zealand (Brown). The insect is, in fact, cosmopolitan.

The following notes on the history of the insect in other places are appended, in the hope that they may provoke discussion, and lead to the publication of suggestions by practical men for dealing with it as an enemy to the silk industry out here.

So long ago as 1839 Westwood, in his Modern Classification of Insects, wrote that *Dermestes vulpinus* occurred throughout Europe and America, and also in Java; that it had at one time done so much damage in skin warehouses in London that a reward of £20,000 was offered for an available remedy, without, however, any being discovered, and that an entire cargo of cork had been destroyed by it, the insects also damaging the timbers of the ship.

[1] This note was originally published in the "*Asian*." The figures are copied from Dr. Riley's plate in the Report of the Entomologist to the United States Department of Agriculture, for the year 1885.

This insect has recently been noticed in America owing to the damage it has done to stored boots and shoes, and its history has there been investigated by Miss Murtfeldt and Dr. C. H. Riley, from the latter of whose account, published in the Report of the U. S. Department of Agriculture for 1885, the following particulars have been taken :—

"The insect was first noticed in the establishment of a wholesale manufacturer of boots and shoes in Saint Louis in 1884, when a lot of boots and shoes were returned condemned as 'wormy;' about the same time the insects were found in numerous leather houses throughout the city and invaded the manufactories, where they retained their partiality for undressed leathers. The work of the larvæ, both old and young, in boots and shoes, consists in boring round smooth channels in every direction through the leather, preferring the soles and heels, though the uppers do not entirely escape.

"The adult beetle is principally occupied in the propagation of its species, yet is also a leather-destroyer, gnawing and scoring the surface of the boot, but not burrowing bodily into substance. The female has been observed to lay some score of nearly cylindrical eggs, each about two millimetres long, pure white, highly polished, slightly larger at one end than the other. The newly hatched larvæ are almost white in color, are covered with long hairs and are quite active, in a few hours acquiring the normal brownish-grey color and burying themselves in their food; they crawl with considerable rapidity, mounting smooth surfaces with ease; they moult six times, at intervals of about a week. The full grown larvæ is a thick hairy brown grub, about 13 millimetres long and one-fourth as broad; it tapers somewhat from the thorax to the anal end, which is bluntly pointed and armed with a pair of thorn-like projections There is a longitudinal stripe down the back, and the six legs are of a reddish-brown color; with these it crawls rapidly with a quick darting motion, dragging the hind body on the surface over which it is passing. The pupa is sometimes found in the larval burrow, but more often the full grown larva leaves the leather and seeks for a crack in the box or floor, often burrowing for its length into the solid wood. In the warehouses where the goods are boxed up in soft wood, the boards are often riddled by these burrows, made by the larvæ seeking for safe places for pupation—this instinct of self-preservation being very necessary, as the larvæ have a fondness for the soft helpless pupæ of their own species, even when other and more natural food abounds. The beetle varies from eight mm. to twelve mm. in length. It presents, on the upper surface, a rather uniform brownish or greyish black appearance, the general color varying somewhat, according to maturity. In the more perfect specimens the dorsal surface is clothed with a very short pale, yellowish and rufous pubescence. The head and a broad band on each side of the thorax are more thickly covered with denser and longer silver-white hairs, while the ventral surface is closely covered with silvery-white pulvescence. Dr. Riley is of opinion that, while the whole of the stages of the insect, from the deposition of the egg to the emergence of the perfect insects may, under favorable circumstances, be gone through in a few weeks, under unfavorable conditions of food and temperature they may extend even to years.

"Where this insect has already effected an entrance, it would, according to Dr. Riley be preferable to overhaul the contents of the box and to treat what is found to be affected with benzine or other insecticide, but where this cannot be done without too great expense, it will probably suffice to open each case and place an open saucer of bisulphide of carbon on top of the contents. The liquid will volatilize, and the vapor will sink down through the mass, if the box be tight, and will kill the insects in their burrows.

"A preventive will, however, be of greater importance than a remedy in this case, and consists in clearing up and burning all clippings, scraps of leather and other refuse that accumulate and become breeding-places for the insect, examining and poisoning hides as soon as they arrive, and frequently examining the stock on hand when there is reason to suspect the presence of the beetle."

13.—FURTHER NOTES ON INSECTICIDES.

Plate IV, fig. 3, force pump; fig. 4, a *ordinary cyclone nozzle,* b *and* c *Vermorel modification of cyclone nozzle.*

An Insecticide for the "Green Scale Bug" of Coffee.

A valuable paper on the "Green Scale Bug" (*Lecanium viride*), which has of late years done serious injury to coffee cultivation in Southern India and Ceylon was published in 1886 by Mr. Ernest Green, who described the remedies that had up to that time been proposed. With regard to these remedies, however, Mr. Green writes:—

"In some cases their application is quite impracticable; in many others, whatever may have been the result with the old bug,[1] they have absolutely no effect upon the new Green Bug."

In fact, up to that time, no satisfactory remedy for the pest had been found. As, however, the insect, which attacks orange trees in Florida, is closely allied to the Indian Coffee bug, it appeared probable that the kerosine emulsions which are being used successfully in Florida against the Orange insect[2] would prove equally applicable to the Coffee Scale in India.

In a paper,[3] therefore, which was published in the Journal of the Agricultural and Horticultural Society of India, kerosine emulsion was suggested for experiment against Coffee Scale.

Results seem to show that the surmise was correct, and Mr. R. H. Morris writes[4]:—

"I have tried with great success an emulsion of kerosine made with common soap on the Green Bug, which has lately attacked coffee estates in the Nilgiris. One part of the emulsion diluted with nine parts of water, and sprayed over the affected coffee trees, kills the bug, whenever it touches, at the first application."

Apparatus.

The chief difficulty appeared to be to obtain the proper apparatus for spraying the bushes with the insecticide, as the spray given by ordinary garden syringes was found to be far too coarse. Several American firms, however, who manufacture apparatus for distributing insecticides, are now sending their force pumps, &c., to the Indian Museum for experiment; while amongst the many practical Entomologists in different parts of India, who are in correspondence with the Museum, it is anticipated that there will be no difficulty in getting the necessary experiments conducted in order to ascertain which of these machines is best suited to the purpose.

[1] *Lecanium nigrum.*

[2] See Notes on Economic Entomology, No. 2, p. 5.

[3] On the work of the United States Entomological Commission, by E. C. Cotes, Journ. Agri.-Horti. Soc. Ind., Vol. VIII, Part II, new series.

[4] In a letter dated 16th July 1888.

In this connection the following remarks[1] by Professor Riley, the United States Agricultural Entomologist, are of interest :—

"There is no large firm in this country which makes a business of handling the various insecticides and machinery, but the trade is divided between some dozen or more principal firms who handle principally goods of their own special makes under proprietary marks or letters patent.

"The cyclone nozzle is manufactured by several firms in this country (it is not patented) also by firms in France and Australia. Thos. Sommerville and Sons, of this city, make the ordinary form at 5 dollars per dozen, and the Vermorel modification at 18 dollars per dozen. This latter style has a degorging rod, and is especially adapted to spraying heavy liquids, as lime-water for fungicide purposes. A wood-cut of this nozzle, entire, and in section, is enclosed (Pl. IV, fig. 4, *b*, *c*); V. Vermoral, Villefranche sur Rhone, France, is the manufacturer in Europe; Kutzner Bros., Masterton, New Zealand, manufacture a single and triplet cyclone; these we have not seen.

"Of pumps we use almost exclusively those made after the style known as the aquapult (pl. IV, fig. 3), the essential feature of which is a piston cylinder in a large outer cylinder, and of such relative dimensions that the downward stroke displaces as much water as the upward stroke lifts, thus securing constant pressure in what is practically a single cylinder pump. The size of the pump must be in accordance with the amount of work desired to be accomplished.

"Paris green and London purple are the only preparations of arsenic in general use here. The former can be supplied readily by any manufacturing chemist, and the latter is controlled entirely by Hemingway and Co., of London and New York City."

An aquapult force pump of the kind recommended by Professor Riley has been received from Messrs. Woodin and Little, of 509, Market Street, San Francisco, U. S. The pump gives a very finely divided spray, but it is impossible to speak definitely as to its merits until it has been tried in the field. It is proposed to have it experimented with, for applying kerosine emulsion to destroy Coffee Scale in South India.

Force pumps have been received from Messrs. Rumsey & Co., of Seneca Falls, New York; they have not yet been experimented with, but appear to be suitable for applying washes, such as London purple and Paris green.

A supply of London purple from Messrs. Hemingway & Co., of 60, Mark Lane, E. C., London, has also been received for experiment.

14.—SHORT NOTES ON MISCELLANEOUS INSECT PESTS.

Lepidoptera.

The Bollworm.

In the Museum collections is a specimen of the Noctues moth *Heliothis armigera*, ticketed as having done injury to the poppy crop in Patna in March 1879; there is also a half-eaten poppy-seed capsule apparently eaten by this worm, which is ticketed as having been damaged by an insect known as *kujra*; that is also injurious to potatoe.

[1] Extracted from a letter dated Washington, 29th May 1888.

In March 1887 specimens of *Heliothis armigera* were received from Arrah, where the insect was said to be injurious to poppy. 1887 some caterpillars, doubtfully[1] referred to this species, were received from Mr. J. Cameron, of Bangalore, who writes that they live chiefly on pulse crops, and especially on *Dolichos lablab*. A single caterpillar, also doubtfully referred to this species, was received in January 1888 from Mr. R. Rainey, of Kulna, who reported the insect as having been injurious to paddy. The Museum contains specimen of the moth which have been obtained rom several localities in India, and the species has been recorded[2] as occurring in Ceylon, Europe, Africa, America, Jamaica and New Zealand.

In America it is known as the "Bollworm," and has proved most destructive to cotton, Indian corn, leguminosæ, and many other plants. A most complete account of it was given by Dr. Riley in the fourth report of the United States Entomological Commission, p. 354 (1885). In the case of the American insect, Dr. Riley notices that the eggs are deposited all over the cotton plant, the larvæ pupating in the ground and generally hybernating in the pupa state, though generation after generation is produced until the approach of the cold weather. Dr. Riley recommends autumn ploughing for destroying the pupæ, in countries where there is frost; the destruction of the moths by poisoned sweets and lantern traps; the destruction of the early broods of larvæ, in the restricted areas where they first appear, by hand-picking, or better by *Pyrethrum*; also the encouragement of insectivorous birds and poultry.

Leucania loreyi.

Some specimens of the Noctuid moth *Leucania loreyi* were received in September 1888, from the Commissioner of Settlements and Agriculture, Central Provinces, with the information that the caterpillar, which is known as *haripok*, has been doing great damage to the rice crop in the Sambalpur district, being reported to have caused a loss of about one-eighth of the crop in some places.

This insect is allied to the cut worms (see p. 33), and has been reported from several parts of Northern India, as well as from Europe, but no details of its life history seem to have been yet recorded in India.

Psychidæ.

Specimens of the larvæ of a Psychid moth, which could not be determined precisely in the absence of the imago, were received in June 1888 from Mr. O. C. V. Johnson of Daladere, Ranchi, with the information that they appear chiefly in November, and infest tea, sâl, and other plants: hand-picking, when the insects appear, being adopted for clearing the tea bushes of the pest.

[1] Mr. Cameron promises to try and rear the moth so that the identity of the South Indian pest may be precisely determined.

[2] See "Catalogue of the Moths of India," Cotes and Swinhoe, p. 271.

This insect does not seem to have been previously sent to the Museum as a pest, but an allied species, *Eumeta crameri*,[1] whose caterpillar builds its case of sticks (instead of the leaves in which the Ranchi insect shelters itself), has long been known as injurious to tea in Darjeeling, where also hand-picking is the treatment adopted.

It is well known that with Psychidæ, each caterpillar builds a case for itself of silk and leaves or sticks, enlarging it as it grows, and pupating within it. The female moth is wingless and never leaves the case, but lays her eggs inside it; while the male moth is winged, often has considerable power of flight, and fertilizes the female as she lies within the case.

The eggs being deposited inside the case, old and apparently dead cases, are just the ones which it is most necessary to destroy, for it is from these that the young insects start.

Achœa melicerte.

In the Museum collection is a specimen of the Noctues moth *Achœa melicerte* bred by Mr. Wood-Mason in September 1887 from a caterpillar said to attack castor-oil plants in the neighbourhood of Calcutta. The range of this insect is a wide one; it has been recorded[2] from all parts of India, besides Celebes and Australia. Nothing seems to be known of it as a pest.

Teak caterpillar.

Specimens of a caterpillar which feeds on teak leaves have been received from Dr. Tomes, of Midnapore, who writes on 26th July :—

"The teak trees in this station are suffering from the ravages of a caterpillar to an extent I have never known before. It is a leaf-roller,[3] with the habit of suspending itself by threads; whole rows of trees have been defoliated by it in a remarkable way, the adjoining trees of other sorts escaping. The insect is now mostly in the pupa stage."

On 7th August he writes—

"They swarmed for a short time; the old eaten-up leaves with pupæ, however, have now fallen off and a fresh crop has come out, and has not been attacked. I am unable to find a single chrysalis. No preventive measures were adopted, the plague ceased spontaneously."

Dr. Tomes sent specimens of the caterpillar and chrysalis, which somewhat resembled those of the cotton worm *Aletia argillacea* of America; but in the present state of knowledge concerning Indian moths it is practically impossible to name Noctues with certainty, except

[1] Determined by Mr. Moore (*vide* letter from Dr. Günther, dated 17th November 1883).

[2] See "Catalogue of the Moths of India," Cotes and Swinhoe, p. 402.

[3] From the specimens received it appears that the pupa is formed on the tree and enveloped in the leaf.

from specimens of the moths. An attempt was made in the Museum to rear the two chrysalids of the pest which were received; no moths, however, were obtained, but from one of the chrysalids emerged a chalcid fly of the species *Chalcis* (*Brachymeria*) *euplœa*, which has also been bred from the Dooars tea pest *Dasychira thwaitesii* (see page 32). Parasites of this kind are probably partly responsible for the disappearance of the pest, and Dr. Tomes is of opinion that the birds discovered and devoured those that were not destroyed by the parasites.

It is hoped that fuller particulars may be obtained when this pest next makes its appearance.

A grain moth.

Information[1] has been received from Mr. J. Blackwood, of injury to white rice, shipped both from Calcutta and London, while lying in Kingston, Jamaica. The injury is due to a grain moth, which from the description appears to be *Tinea granella* (or the "Wolf Moth").

One Jamaica firm writes that up to 1882 rice could be held for as long as twelve months without injury, but that, lately, rice shipped from Calcutta has been found affected a fortnight after receipt; and one shipment from London, three weeks after it was landed, had to be sold far below its original market-value; part of it indeed being actually thrown away. The firm writes—

"A small moth, like the moth that attacks furniture at home, seems to be the enemy; the rice becomes filled with millions of small worms that collect hundreds of grains around them enfolded in a web which is inseparable, and the grains are then eaten through to a shell. Yellow rice does not appear to suffer so quickly, but, as we expect shortly 1,500 to 1,700 bags, it is a serious question. We have not now a bag on our wharf, and at considerable expense we have had every store on our premises cleaned, whitewashed and disinfected with carbolic acid, and will stow every bag in sprinkled salt in the hope of curing the evil which threatens the extinction of our trade. We ascribe this visitation to low stores, which since the fire of 1882 are now by law all covered with iron, and not being sufficiently ventilated, generate too much heat. Our losses have been heavy, but the worst effect is that we fear to hold any stocks, without which the trade would virtually have to be abandoned."

The conditions which control the increase of this pest do not seem to be completely understood, the insect occurring all over the world but only occasionally doing serious injury. Reports have not reached the Museum of injury by it in India, but there is evidence to show that it already exists here, and so at any time may become destructive.

Curtis in his work "Farm Insects," p. 315 (Edinburgh 1860), gives an excellent account of this pest. He notices that when the larvæ have become full-fed in the heaps of grain, they hide themselves away in cracks and crannies, sometimes burrowing for a considerable distance into hard wood, in order to secure shelter during their chrysalis

[1] Dated Calcutta, 20th June 1888.

stage. In cleaning out the granaries, therefore, it would seem desirable to take special care to whitewash all old wood-work with hot lime, so as to fill up the crannies and burrows where the larvæ have taken refuge. Curtis notices a number of other recommendations that have been made for dealing with the pest, one of them being to sprinkle the grain with salt, as is being done in Jamaica; but the most promising measure with the Wolf Moth, as with the Wheat Weevil,[1] seems to be the thorough cleaning up of the granaries.

Paddy caterpillar.

Obscure lepidopterous larvæ, which it is quite impossible to determine precisely without examination of the moth, have been received through the Director of Land Records and Agriculture, Bengal, forwarded by the Commissioner of Chittagong from Mr. Cosserat, who writes that they are known locally as *Sirmayee poka* or *Sirmayeilock*, and that they are said to cause "considerable damage to ripe paddy crops by separating the bunches from their sheaves." They are reported to have been particularly numerous in Baraghope and Koiarbil, in places where the rice escaped damage by salt water.

From this description it is probable that the insects belong to the group of "cut worms" (Noctues,—see p. 33), but specimens of the moth should be sent for precise determination.

Specimens of a second pest, known locally as *Silain poka*, were received together with the above from Mr. Cosserat, they are said to injure rice in the same way, and probably belong to the same group, but the species cannot be determined from the imperfect specimens received.

Katree poka.

Caterpillar of a Noctuid moth, too obscure for identification without having the perfect insect, have been received through the Director of Land Records and Agriculture, Bengal, to whom they were forwarded by the Collector of Balasore from Koylash Chandra Rai, who writes:[2] that they are known locally as *Katree poka*, and that they destroy yong paddy plants, mostly in seed beds, by cutting off the plants as if with scissors just above the water. Specimens of the moth and further particulars are desired.

Jute caterpillar.

Specimens of an insect were forwarded to the Museum by the Director of Land Records and Agriculture, Bengal, from Babu Kali Narayan Roy, Manager of the

[1] It appears that the "Wolf Moth" is not so exclusively confined to granaries, throughout the whole of its life as is the Wheat Weevil, though it passes the greater part of its existence there.

[2] Letter dated Dehurda, 26th August 1888.

Chanchal Estate, Maldah, who reports that they are destructive to the jute crops.

The insect in question is probably *Spilarctia suffusa*, which is figured by Moore in his Catalogue, Lep. Mus. E. I. C., pl. xvi, fig. 10. This insect is a moth belonging to the family Arctiidæ, which feed almost exclusively on the leaves of plants, some of them being very destructive. They generally form their cocoons of hair and silk on the leaves or stalk of the plant they attack, the perfect insect being a small brownish moth.

With regard to remedies which are likely to be practicable, no information has been received. Hand-picking, or spraying with an insecticide would no doubt destroy a great many of the caterpillars, but it is very doubtful to what extent it would pay to adopt either of those measures.

Fuller particulars concerning the pest, and also live specimens, especially of the pupa (chrysalis or cocoon), are desired to form a record for future reference.

Palu pok.

Some imperfect specimens of what appears to be the Arctiid moth *Aloa lactinea*, Cramer, were received on 8th October 1888 from the Commissioner of Settlements and Agriculture, Central Provinces, with the information that it is an injurious insect known in the Sambalpur district as the *bhalu pok*. This is a well-known insect, though little has been recorded of its life history; it is one of that large group of Bombycid moths whose larvæ feed on the leaves of plants. It is hoped to publish fuller particulars of it hereafter.

Upland rice caterpillars.

Caterpillars of two species of Bombycid moths which cannot be precisely determined in the absence of the perfect insect, have been forwarded by the Director, Land Records and Agriculture, Bengal, from the Agricultural Officer of Ranchi, who notices that they attack *gora dhan* (upland rice), one of them being also found on *Maruá* (*Elusine carocana*). He writes [1]:—

"I have examined many fields of *Gorá* and *Maruá*, not one of which was exempt from the ravages of these pests. ..... I cannot form an estimate of the damage caused by these caterpillars; but the fact that they are seen on every fourth or fifth blade of *Gorá* and *Maruá* (which, by the way, are the two principal upland crops of this province) shows that the damage caused by them must be more than appreciable."

Brinjal borer.

Specimens of a caterpillar that injures brinjal by boring into the stems, and which is either identical with, or nearly allied to, the Sugarcane borer, *Diatræa saccha-*

[1] In a report to the Director, Land Records and Agriculture, Bengal, dated 5th September 1888.

ralis, Fabr. (*vide* p. 22) have been forwarded by the Director of Land Records and Agriculture, Bengal, from the Agricultural Officer of Ranchi, who writes[1]:—

"Regarding the little grub found inside the fleshy stem of brinjal shoots, on examining the shoots, a minute aperture will be found which is nothing else than the puncture which the female insect must have made with the ovipositor while laying her egg. On breaking the shoot just at this puncture, a small whitish grub will be found. ... This pest has done a very considerable amount of damage to the brinjal crop in all the gardens that I have had the opportunity of examining in this town."

In one place he notices that all the plants had been killed by it; in another ten per cent. of the plants had already died off, and most of those that remained were still suffering from it, early sown plants being more severely attacked than the late sown ones. Tobacco-water was tried in one garden without effect.

Chan caterpillars.

Caterpillars have been received through the Collector of Balasore, forwarded by the Director of Land Records and Agriculture, Bengal, from Dehurda,[2] where they are reported te injure the fibre plant called *Chan*. The insect enters the *dhooly*, or fruit of the plant, and eats up the seed, and sometimes also the leaves and the upper part of the plant itself. No remedy is known, but heavy showers of rain are said to check the evil.

These are larvæ of a Noctuid moth; specimens of the moth should be sent for precise identification.

Leda poka caterpillars.

Caterpillars of a Noctuid moth have been received through the Director of Land Records and Agriculture, Bengal, from the Deputy Collector in charge, Tipperah, who writes[3] that they are known as *Leda poka* and are very injurious to crops. Specimens of the moth should be sent to enable the insect to be precisely determined.

Tea borer.

A single immature caterpillar of a boring moth, injurious to tea bushes, has been received from the late Mr. Otto Möller, of Darjeeling, who wrote (8th March 1888):—

"It can hardly be termed a pest, as it occurs rather sparingly. The stems, however, when attacked, are doomed to destruction. As far as I can make out, it is found right from the Terai up to the highest elevation to which tea is grown here in the hills."

It is quite impossible to determine this insect precisely from the specimen received, but it is probably one of the Hepialidæ, a group of

[1] In a report dated 5th September, addressed to the Director, Land Records and Agriculture, Bengal.

[2] Obtained by Baboo Koylash Chandra Rai.

[3] In a letter dated 29th September 1888.

moths well-known, all over the world, as containing numerous wood boring species. The caterpillar can no doubt be easily killed by injecting a little kerosene into the hole which it makes in the tea stem, or even by plugging up the hole with a wooden peg; it is very questionable, however, whether it will be found worth while to adopt any such measures. Live chysalids of the insect might be sent to the Museum to be reared and determined; they will, no doubt, be found in the burrow near its opening.

Sugarcane moth.

In the Museum collection is a specimen of a small moth ticketed as injurious to sugarcane, and identified by Mr. Moore as belonging to a species described by Walker in his Catalogue, Lep. Het. B. M., pt. XVI, p. 200, as *Dragana pansalis*. No further information has been obtained about it.

A Museum pest.

In the Museum collection is a specimen of a Microlepidopterous insect, which was identified by Mr. Moore in 1879 as belonging to the species *Tinea lucidella* (Walker, Cat. Lep. Het. B. M., pt. 28, p. 474). Attached to the insect is a ticket marked "The larva is very destructive to the horns of hollow-horned ruminants." No further information has been obtained concerning it.

Horra caterpillar.

From the Central Museum, Madras, were received (25th October 1888) some caterpillars of a Noctuid moth, for the precise determination of which the imago is required. The caterpillars were reported [1] by the Collector of Kurnool to have appeared in a village in his district, and destroyed Horra (Indian Millet).

Coleoptera.

Opium and cheroot beetle.

In May 1884 some specimens of a beetle were sent to the Museum by Dr. L. A. Waddell, of Calcutta, with the information that they infested the leaf covering of opium balls; in August 1887 specimens were received from Surgeon P. A. Weir, Opium Factory, Ghazipur, North-Western Provinces; and in March 1888 specimens were received from Mr. J. Blackwood, who found them in rice in Calcutta.

The insect was identified as *Lasioderma testaceum*, by Mr. C. Waterhouse of the British Museum, who noticed that the insect is almost cosmopolitan and well-known for attacking various vegetable substances.

In his report on the Ghazipur insect, Mr. Wood-Mason noticed that the same beetle is frequently found in Manilla and Indian cheroots.

[1] Letter No. 3149, dated 12th October 1888, forwarded by the Superintendent, Government Museum, Madras.

The writer learns from Mr. R. Chapman that in England the sale of Indian cheroots (especially Trichinopoly cheroots) is seriously interfered with on account of a boring insect, which is probably this species.

Curculionid pests in Darbhunga.

Specimens have been forwarded by Mr. H. S. Beadon, C.S., from Mr. Beck, of two species of Curculionid beetles which have proved injurious in the Raj gardens, Darbhunga. Of one of these insects Mr. Beck writes that it appeared in May, when it was found eating away the stems of this season's growth, thereby causing the young shoots to wither and die, and in some cases killing the plant outright. He notices that since the rains the plants have been more vigorous in growth, and have resisted the attack of the insect better than they did in the early part of the season. This insect has been determined as *Desmidophorus hebes* of Fabricius; it appears to be fairly common in India, but has not been previously reported as a pest.

Mr. Beck writes that the other pest attacked the leaves of the "*Some*" plant in the same gardens. This insect is probably *Astycus lateralis*[1] of Fabricius, and has previously been sent to the Museum as destructive to the leaves of mulberry in Rangoon.

No particulars as to their life histories have yet been obtained for either of the species.

Epilachna viginlioctopunctata.

Specimens have been received from the Director of Land Records and Agriculture, Bengal, of an insect said to be injurious to brinjal plants. Baboo Kailash Chandra Rai, of Dehurda (Balasore), reports—

"It has no special name. It appears generally in the rainy season and damages young plants, and disappears when cold weather sets in. Incense is burnt in the brinjal fields with a belief that its smoke prevents the pest, but it cannot be said that it is a sure and certain remedy of the same!"

The specimens received appear to belong to the species *Epilachna vigintioctopunctata* of Fabricius, which has been recorded[2] as occurring in India, Java, China, Sumatra, New Guinea, Japan and Australia. This is a beetle belonging to the group Coccinellidæ, almost all the

[1] There is some doubt about the precise determination of this species.

[2] *Vide* Gemminger and Harold's "Catalogus Coleopterorum," Vol. XII, p. 3815, where the following synonymy and references are given,—

vigintioctopunctata, Fabr., Syst. Ent. 1775, p. 84.
Herbst. Käf. V, p. 264, t. 55, f. 3.
Muls. spec., p. 834.
Montrouz. Ann. Soc. Agr. Lyon. VII, 1855, p. 75.

Var. *egens*, Muls. spec., p. 836, *implicata*, Muls., l. c., p. 837: *lacertosa*, Muls., l. c., p. 838; *multipunctata*, Muls., l. c., p. 836; *recta*, Muls., l. c., p. 836; *sparsa*, Herbst. Füessl Arch. VII, 1786, p. 160, t. 43, fig. 11; *pubescens*, Hope, Gray, Zool. Misc. 1831, p. 31; *24-maculata*, Fabr. Ent. Syst. I, 1, p. 281; *28-maculata*, Motsch. Etud. Ent. 1857, p. 40.

species of which are carnivorous in their habits, many of them feeding on aphids (plant lice), and being on this account most useful to agriculture, though the group also contains some species that feed on leaves.[1] It would be desirable, therefore, to observe this insect carefully in order to ascertain that it is really a pest, before taking measures to exterminate it.

Cockchafers.

Specimens of a cockchafer (*Melolonthini*), received from Dr. George King, are to be found in the Museum collection. Dr. Anderson wrote of them[2] that they have proved most destructive to the public gardens in Darjeeling, and threatened to extend their ravages.

The following extract is from a report by Mr. Jeffrey, forwarded by Dr. George King, from the Darjeeling Gardens :—

"They appear to form a cell in the soil, and when taken from it do not appear to thrive. I made up the figures yesterday of what numbers were destroyed, and I found, from nearly a month's work, they amount to 2,695,000, so that I have rid the world of a goodly number."

Dr. Günther, of the British Museum, to whom specimens of the insect were submitted, wrote[3] :—

"The beetle is most likely *Lachnosterna impressa* (Burmister. Handb., IV, 2, p. 314, Assam) : but the genus is a most difficult assemblage of very numerous and closely allied species. Another species (*L. pinguis*, Walker) is mentioned as destructive to coffee trees by Haldane in his pamphlet 'All about grub,' Colombo, 1881."

Specimens of the larvæ, either of this species or of an insect very closely related to it, were received in July 1881 from Mr. L. R. Forbes, of Chittagong, with the information that it attacks the roots of paddy, *kachoo*, and Indian-corn, emerging from the ground in July and August. Paddy, which is covered with water in July and August, is said to be unaffected.

Stromatium barbatum.

Some slight damage has been done during the past year, to deal-wood boxes lying in the godowns of the Museum, by the larvæ of the Cerambycid beetle[4] *Stromatium barbatum* of Fabricius; imagos emerged in March. The life history of this insect does not seem to have been yet observed in India.

Cicindela 6-punctata.

Specimens of the beetle *Cicindela 6-punctata*, Fabricius, have been forwarded by the Collector of the 24-Pergunnahs, from the Sub-divisional Officer of Diamond Harbour,

[1] *Vide* Westwood's "Modern Classification of Insects," Vol. I, p. 397.

[2] Letter dated 22nd May 1883.

[3] 17th November 1883.

[4] See Gemminger and Harold's "Catalogus Coleopterorum," p. 2810.

with the information that they are known as "*sansi* insects, and are said to cut the stems of plants." This beetle, however, belongs to a family of exclusively carnivorous insects, and it is therefore very improbable that it can have occasioned injury to plants. This insect is often found in large numbers in rice-fields, especially near the sea-shore. The injury referred to has probably been done by a species of Cut worm (Noctues).

Cerambycidæ.

Specimens of three species of Cerambycid beetles, injurious to trees, have been received from the Director of the Forest School, Dehra Dun:—

No. 1—has been found in sâl (*Shorea robusta*) in Oudh, and in saj or sain (*Terminalia tomentosa*) in Dehra. This insect is probably *Neocerambyx holosericeus*, Fabr.

No. 2—has been found in sâl (*Shorea robusta*), and jinghan (*Odina wodier*), in Dehra Dun. This insect forms a calcareous egg-like case, in which it pupates. It is, no doubt, the insect described by Mr. R. Thompson in his Report on insects injurious to woods and forests (1867), p. 415, pl. VIII, figs. 1 and 2: it has been determined as *Plocederus pedestris* of White.

No. 3—A girder longicorn beetle, of which a practical account is being published in the "*Indian Forester*."[1] It is probably *Cælosterna scabrata*, Fabr.

A block of sâl wood from Dehra Dun has also been received, which is simply riddled with burrows of cerambycid larvæ (probably those of No. 1). The borers appear to have first lived on the sap wood, afterwards burrowing into the very heart.

It is hoped to give a more complete account of these insects hereafter.

Cholum pest.

From the Central Museum, Madras, were received some specimens of a beetle, *Cantharis sp.*? which were reported[2] by the Collector of Kurnool to have eaten up the leaves of yellow cholum (millet), and thus destroyed the crop in one village in his district.

Biscuit beetles.

From Mr. W. N. Duncan, of Calcutta, were received (21st June 1888), specimens of beetles which injure ship's-biscuits. These insects were sent to Dr. Günther, of the British Museum, who kindly promised to have them examined. He reports upon them as follows:—"All common warehouse insects, *Silvanus surinamensis*, *Rhizopertha pusilla*, and *Tribolium ferrugineum*.

[1] *Indian Forester*, November 1888.

[2] *Vide* letter forwarded by the Superintendent, Government Museum, Madras, dated 12th October 1888.

Rice scolytid.

A single specimen of a scolytid beetle was received from Captain Bingham, of Rangoon, who had found about an acre of rice, situated near the sea, completely destroyed by it. Captain Bingham found that the insect bored into the stalks; he promises further particulars.

Boring beetles.

From Mr. B. L. Frizoni, of Hazaribagh, were received some large Bostrychid (Apatid) beetles. Several of these insects were found (April 1888) alive in the interior of the stem of a young guava tree which they had killed. They were sent to Europe for precise determination.[1] Part of the stem of a coffee bush was also received, which had been destroyed by the larvæ of a boring beetle, which is probably *Xylotrechus quadrupes*, Chevr., the "Coffee-borer" of South India. Dr. Bidie described this pest in a report published by the Government of Madras in 1869; he found that shade and good cultivation were the best preventives.

Kapra.

Larvæ of a Dermestes beetle were observed by the writer, in March 1888, in vast numbers in wheat godowns in the Delhi market, where they shelter themselves under the plaster on the walls. The owners of the godowns averred that this pest, which they called *kapra*, sometimes destroys as much as six or seven per cent. of the wheat, which is stored in a godown. The larvæ were reared in the Museum, and specimens of the beetle sent to Dr. Gunther, of the British Museum, who kindly promised to have them examined. He reports on them as Dermestidæ apparently belonging to a species of *Trogoderma* not previously represented in the British Museum collections.

Orthoptera.

Schizodactylus monstrosus.

Specimens of an insect have been forwarded to the Museum by Baboo A. Lall Chatterjee, of Pusa, Darbhunga, who notices that it is known in that neighbourhood as *Bherwa*, and that it lives in holes about half an inch in diameter, which it constructs in the ground. He reports that it cuts the roots of the young plants of the *mokai*, tobacco, *morwa*, and other crops growing on high lands, and also injures the leaves of tobacco and cauliflower.

[1] These insects were sent to Dr. Günther, of the British Museum, who kindly promised to have them examined. He has since reported on them as belonging to four species of Bostrychidæ, *viz.*, *Sinoxylon* (species new to the British Museum collection), two species of *Bostrychus*, which are not named in the British Museum collection, and *Cœnophrada anobioides*, Waterhouse (Ann. Mag. Nat. Hist., 1888).

This is an orthopterous insect, determined as *Schizodactylus monstrosus*; it is hoped that further particulars may be obtained concerning it.

Locusts.

Specimens of an insect which resembles the migratory locust, *Acridium peregrinum* of Western India, have been forwarded by the Officiating Collector of the 24-Pergunnahs, from Raja Durga Churn Law, who notices that the insect is most destructive in Nuddea, Hooghly, the 24-Pergunnahs and Midnapore, coming in swarms, which darken the horizon and destroy whole fields. No information has hitherto been received of the presence of true locusts in Eastern Bengal, and until these specimens shall have been compared with types of the Western locust, the writer is inclined to look on them as probably distinct from it. The matter, however, is one of considerable interest, on which it is to be hoped further light will be shown.

The Indian Museum does not, at present, possess authentic specimens of the insects, which are known in India as "Locusts," and which from time to time do such serious injury to vegetation in the Punjab, and in Western and Southern India; information[1] also has been received from Surgeon-General Edward Balfour, in London, that the British Museum is similarly situated.

It is very desirable that this pest should be fully investigated, the writer therefore would suggest that authentic specimens from different localities should be obtained and sent to the Indian Museum, where some of them can be preserved for reference, and others forwarded to the British Museum, and European specialists, for examination. To secure authenticity the specimens should, in each case, be taken from some destructive swarm, as there are a large number of other grasshoppers in India, which very closely resemble true locusts in appearance, and are therefore liable to be mistaken for locusts, though they do not "migrate," or occur in sufficient numbers to occasion serious injury.

The first point which has to be settled about locusts in India is whether the destructive flights which periodically appear in the Bombay, Punjab, and Madras Presidencies, are invariably *Acridium peregrinum*, the species described by Dr. Macdonald as the locust which proved injurious in the Bombay Presidency in 1883, and which has so often invaded large areas in Northern Africa and South-Western Asia.

Winged locusts, besides the wingless larval forms and eggs, can readily be killed and preserved by dropping them alive into bottles of alcohol, which should be carefully filled up and closely corked to prevent damage by jarring on the road.

[1] A letter to the Secretary, Revenue Board, Calcutta, dated 22nd November 1888.

A summary of what has been recorded about locusts in India is being prepared and will appear in an early number of these "Notes."

Neuroptera.

White ants.

The Commissioner of Chota Nagpore (Mr. C. C. Stevens), writes [1]:—

"*White ants.*—These are, according to Mr. Driver, a Tea Planter, the only insects which do any harm to the tea cultivation in Lohardaggah, but these he gets rid of by constant deep-hoeing. They do not confine their attacks to tea, but most plants are more or less liable to be damaged by them, though the Manager of the Chota Nagpore Raj doubts whether they can attack healthy growing plants. Sugarcane in the Giridhi Sub-division, says the officer in charge of it, is especially liable to the attack of this insect. The Manager of the Chota Nagpore Raj says that its mode of attack is to eat up the root of live crops and cause the plants to die. The ryots, he says, are not acquainted with any remedy for it."

The Personal Assistant to the Director of Land Records and Agriculture, North-Western Provinces, notices,[2] that until the sugarcane borer (*Diatraca saccharalis*, Fabr.) appeared near Cawnpore, white ants had been found to be the most serious pest with which sugarcane had to contend, though they could always be more or less effectively checked by heavy watering.

Several queen white ants in various stages of development, and also a complete nest, have been received[3] from Mr. J. Cleghorn, Balasore. White ants seem to be particularly plentiful in Balasore, and Mr. Cleghorn has already observed one interesting fact regarding them, namely, that the royal cell is often occupied by several queens in various stages of development, there being in some cases two or three fully-developed queens, with their sausage-like bodies laid side by side; in others a single fully-developed queen,[4] together with an active young queen, which has evidently but recently lost its wings.

A summary of what has been recorded about white ants in India is being prepared, and will appear in an early number of these "Notes."

Diptera.

Silkworm fly parasite.

Specimens in all stages of development of a parasite of the Bengal Silkworm Fly (*Thrycolyga bombycis*, Louis), have been received from Mr. C. Marshall, of Berhampore, who writes [5]—

"The eggs of the midge were deposited on the grub of the silkworm fly, within a few hours of the grub's cutting out of the silkworm cocoon it destroyed."

[1] In a report, dated 26th October, forwarded by the Director of Land Records and Agriculture, Bengal.

[2] In a report dated 30th April.

[3] Through Mr. R. Blechynden, of the Agri-Horticultural Society of India.

[4] It has been usually supposed that but a single queen is to be found in each nest.

[5] In a letter dated 11th September 1888.

The "midge" proves to be itself a dipterous insect; it could not however be identified precisely in the Museum, and will therefore be sent to Europe for comparison.

A good deal of information has been collected about the silkworm fly which it is hoped will form the subject of a future paper.

Lahikeeda or Bhua keeda.

Specimens of a pest known locally as *Lahikeeda* or *Bhuakeeda* have been received through the Director of Land Records and Agriculture, Bengal, from the Deputy Commissioner of Hazaribagh, with the information that it attacks *urid*, *barae* and *sino*, when they are almost ready for being harvested, and destroys them completely.

Amongst the leaves and stems forwarded in alcohol, were found a few pupæ of a dipterous insect. This material, however, is quite insufficient to determine the species, or even to ascertain whether this dipterous insect is the real cause of the mischief. Live specimens of this pest should be sent, so that they can be reared in the Museum.

Miscellaneous pests.

Ganjam insect pests.

The following is from a Report dated September 1888 from the Collector of Ganjam, which was forwarded to the Museum by the Revenue and Agricultural Department of India, together with specimens Nos. 1 to 7 :—[1]

"1. *Pesalu purugu.*—Reported to infest green gram (*Pesalu*). This is a beetle belonging to the genus *Bruchus*. It is hoped to determine it more precisely when the specimens are returned that have been sent to Europe for comparison.

"2. *Kunkudiya purugu.*—Reported to destroy cotton, red gram, and cucumber; comprises two species of insects, namely, a chrysomelid beetle, *Aulacophora abdominalis* of Hope, which is probably the insect which does the damage; also a coccinellid beetle, *Palæopeda sexmaculata*, which is probably predacious in its habits, and therefore little likely to occasion damage to plants. Specimens of *Aulacophora abdominalis* were also received on 23rd June from the Department of Land Records and Agriculture, North-Western Provinces, where they were said to attack water caltrop (*Trapa bispinosa* = *soonghara*).

"3. *Monjikila purugu.*—Reported to destroy paddy, sugarcane and brinjal plants by eating away the pith of the stalk. This appears to be the same as the sugarcane borer moth *Diatræa saccharalis* of Fabricius, see paper on this pest, p. 22.

"4. *Nooludaram purugu.*—Reported to attack sugarcane, paddy and brinjals. This is the caterpillar of a Noctuid moth, *Achæa melicerte*.[2]

[1] Specimens of the moths are required for the precise determination of Nos. 5, 6, 7, 8, 9 and 10.

[2] See also p. 52.

"5. *Penki purugu.*—Reported to destroy country beans and other vegetables. This is the caterpillar of a Noctuid moth.

"6. *Koora purugu.*—Reported to kill vegetables. This is the caterpillar of a moth (probably one of the Pyrales).

"7. *Kandula purugu.*—Reported to feed on red gram. This is the larva of a Noctuid moth.

"8. *Gongali purugu* (caterpillars).—These insects are generally found in clusters, and damage gingelly, castor-oil, ragi, *drumstick* (*?*) and several other plants, as well as *Gmelina arborea* (*?*), beans and other vegetables; some flower plants are to some extent affected by them. In short, the caterpillar's range of damage is far wider than that of any other insect.

This was reported (20th October 1887) to be the larva of a moth belonging to the Heterocerous family *Arctiidæ*, and probably to the genus *Spilosoma*.

"9. *Vanga purugu.*—This is particularly partial to brinjals, as the name imports. Was reported (20th October 1887) to be the larvæ of a pyralid moth.

"10. *Aku Telu.*—These spring up in February or March, and infest the green gram crop. Reported (20th October 1887) to be larvæ of a bombycid moth belonging to the gernus *Parassa* of the family Limacodidæ."

Monghyr pests.

Some grasshoppers and caterpillars have been received[1] from the Sub-Divisional Officer of Jamui, Monghyr, who writes that they both destroy posta (opium plants) and rabi crops (such as grain and wheat) by devouring the leaves. He notes that the grasshopper is known locally as *Fatinga* or *Gaduhya*. This insect is the same as what has been determined in the Museum collection as *Crotogonus lugubris*, Bland.: it has also been received[2] from the Department of Land Records and Agriculture, North-West Provinces, as injurious to indigo. The caterpillars are Heterocerous larvæ, but are too obscure for precise identification without having the moth; they are said to be known in Jamui by the name of *Pilloo*.

Mahogany borers.

From Mr. Donald Sunder, C. S., Alipore, Western Dooars, have been received specimens of mahogany wood, and also of boring grubs which have proved injurious to it. Mr. Sunder writes on 20th September—

"Two years ago I planted several mahogany seedlings in Alipore. They got on very well, and the young trees were looking very healthy. Two trees began withering

[1] Received on 2nd January 1889.

[2] Received 23rd June 1888.

last week and died, each after the other. As the Forest Officer of Buxar told me that his mahogany trees had failed in the Reserve Forest, I tried to find out why my trees had died, and for this purpose I cut down the dry trees and examined them. I found the bark, up to about two feet from the ground, eaten by some worm. On removing parts of the bark I found several white worms in the heart wood. These worms had eaten into the wood and had killed the trees."

On examination the borers were found to belong to two species of insects, *viz.* (1) a few odd larvæ of the moth *Magira robusta*, Moore, which have been noticed elsewhere (see page 35); (2) larvæ of a beetle, probably one of the Curculinonidæ, but which it has not been possible to determine precisely in the absence of the perfect insect. The borers have gone very little into the hard wood, and seem to have killed the trees by making galleries close under the bark.[1]

Nuddea pests.

The following is a report on the insect pests, from the Collector of Nuddea, that were forwarded to the Indian Museum by the Director of Land Records and Agriculture, Bengal.—(See his letter No. 149, Agriculture, dated Calcutta, 17th January 1889.)

The specimens were found to be mostly dried up, and consequently could only be precisely determined in a few instances. Some of the pests referred to by the Collector of Nuddea, in his list dated 19th November 1888, were unrepresented by specimens; while in some cases specimens were found of which no mention had been made in the list; and in others it would appear improbable that the specimens forwarded are really the cause of the damage of which they are accused.

Kuti poka, said to attack the tender parts of the leaves, stalks, and flowers of paddy from May to July, disappearing when heavy showers fall. The box was found to contain some grains of *dhan*, with a number of specimens of a small grain moth *Tinea sp.* and a single specimen of a Hemipterous insect kindly identified by Mr. E. T. Atkinson as *Chrysopelta schlaubuschii*. The small moths are probably purely granary pests; and the Hemipterous insect is unlikely to occasion serious injury in the fields.

Dheno foring, said to attack the tender parts of leaves, stalks, and flowers of paddy in the month of May, disappearing when the cold weather comes.

The box was found to contain fragments of an Acridid insect (Orthoptera), which was too much smashed for precise identification.

White ants, said to attack the roots, and at times the stems of young

[1] There does not seem to be any very definite remedy applicable to this kind of pest, except perhaps the radical one of cutting away and burning the parts attacked; but it seems to be pretty well established that boring insects of this kind confine their attack to trees which have had the healthy flow of the sap interfered with, either through mechanical injury, or through being in a generally unhealthy state.

plants of all sorts of crops, especially paddy, jute, and *arhar*, also all vegetables, sugarcane, and big trees; also rice in granaries, timber in buildings, and books in almirahs. They are said to disappear from the roots of crops when heavy showers fall, but never to disappear from the roots of trees.

These are white ants *Termites* (Neuroptera).

Aucha poka, said to attack the tender leaves of pulse of all kinds, linseed, *jub*, and *teel*, appearing at the time that the seed germinates, and disappearing when the plants get strong. These are Bombycid larvæ (Lepidoptera), which cannot be precisely determined from the imperfect specimens.

Sarashi or *Kalia poka*, said to attack the roots of wheat, barley, peas, *mushur*, gram, *kolai*, *moog*, linseed, *khesari*, mustard, and sugarcane, when the plants are young, disappearing when the plants grow stronger. These are obscure dried larvæ and pupæ of a Lepidopterous insect.

Hana, said to eat the seeds (*i.e.*, fruits produced and not those sown) of *mator*, *khesari*, and gram in January, when the wind blows from the south. These are indistinguishable Lepidopterous larva.

Jhenji poka, said to attack the roots of sugarcane, rice and chilly plants. There being no specified time for the appearance or disappearance of this pest, which is very scarce and does but little harm. These are two Orthopterous insects, *viz.*, *Schizodactylus monstrosus*, and a species of *Gryllus*.

Small ghora poka, said to attack *moog* in April, disappearing with the fall of rain. This is *Bruchus sp.* (Coleoptera).

Large ghora poka, said to attack wheat. This is *Mylabris pustulata* (Coleoptera).

Kapasi poka, said to destroy cotton plants. This insect has been kindly determined by Mr. E. T. Atkinson as *Lohita grandis* (Hemeptera).

Gaudi poka.—This is a Hemipterous insect kindly determined by Mr. E. T. Atkinson as *Aspongopus brunneus*.

Hena poka, said to destroy rice, gram, &c. This is the "wheat and rice weevil," *Calandra oryzæ* (Coleoptera).

Shesisha poka, said to attack mustard. These are remains of obscure caterpillars with many cocoons of chalcid parasites and two pupæ of a *tachinid fly*.

Grasshoppers foring.—These comprise at least two species of Orthopterous insects—(*a*) with produced head *Atractomorpha sp.*, (*b*) not recognized.

Mal poka, said to destroy grain plants. This is the larva of one of the *Sphingidæ* moths.

Baga poka, said to damage plants and vegetables, comprises two

species of insects—(*a*) *Epilachna pubescens* of Hope (Coccinellidæ). (*b*) *Aulocophora abdominalis* of Hope (Chrysomelidæ).

Gunga fering.—This is *Atractomorpha sp.* (Orthoptera).

Footi poka.—These are small obscure Microlepidoptera, probably grain moths, *Tinea sp.*

Jale poka.—This is *Haltica cærulea*, Oliv. (Coleoptera).

Locusts, reported to attack all crops, there being no fixed time for their appearance, though it is generally said that they appear in the beginning of summer, and only disappear after eating up the entire crop. (No specimens.)

Pat poka, said to attack the tender leaves of jute in May, disappearing when heavy showers fall. (No specimens.)

Rosha poka, said to attack the tender stalks of winter paddy, at the time when it is in the ear. They are said to disappear after a fall of rain, or with the setting-in of the cold weather. (No specimens.)

Juba poka, said to attack the flowers of mustard and tobacco, disappearing at the same time as the flowers. (No specimens.)

Majura, said to attack the leaves of sugarcane in May, June, July, and August, disappearing when the canes are stripped of their leaves. (No specimens.)

Nala poka, said to attack the seeds of gram and til. (No specimens.)

Hatia poka, said to attack the inside of paddy stems in September and October. The insect resembling a white thread, and being supposed to germinate inside the plants. It is said to disappear if there is rain in October, but to destroy the plants altogether if no rain falls. (No specimens.)

Khara poka, said to attack the tender plants of jute in June or July, and pulses of all kinds in November. It disappears from the jute when heavy rain falls, and from the pulses with the setting-in of winter. (No specimens.)

Tanta poka, said to attack seed stored in granaries. (No specimens.)

Sara poka, said to attack stored rice. (No specimens.)

Undetermined Pests.

A paddy pest.

Some specimens of a pest were received on 26th September, through the Collector of the 24-Pergunnahs from Baboo Kally Coomar Roy Chowdhari, who reported that they were at that time destroying what remained of the paddy crop in fields which had been ruined by excessive rain, and which the cultivators had therefore neglected, paddy still standing in water being untouched. The specimens arrived in such a bad state of preservation that nothing could be made out of them; fresh specimens should therefore be sent.

Tota poka.

Some dried rice stalks, damaged by an insect described by the Collector of Bankura as the *Tota poka* were received in the begining of October, with the information that the insect had begun to attack the *amun* rice plants, but had not, up to that time (1st October), done much mischief. Fresh specimens should be sent, as it has not been found possible to make anything out of the dried stalks received.

15.—EXTRACTS FROM REPORTS.

[NOTE.—The following extracts and abstracts are taken from letters and reports which have been received without specimens. The information they contain will be of value when the insects to which they refer have been determined; for this purpose specimens should be forwarded, for without the specimens the identity of the insects cannot be definitely ascertained.]

Report from Basirhat.

The following is taken from a report, dated 5th November 1888, by Baboo Purno Chandra Chatterjee, Deputy Collector of Basirhat, forwarded by the Collector of the 24-Pergunnahs—

"*Shua poka*, a hairy caterpillar, two or three inches in length, and black or brown in colour; the hairs with which it is covered produce irritation when they get into the skin. It is very injurious to jute, sometimes entirely destroying extensive fields of this crop. It occurs in June, and is universally supposed to be due to drought, not appearing when there is the usual amount of rain. It is said that *vádri*, or early jute, which is cut in August, is more subject to attack than is *kartiki* (or late jute), which is cut in October. Very young jute plants and also old plants which have run to seed are not attacked. The pest appears suddenly, fields extending over several bighas of land being found covered with caterpillars at the very commencement of the attack. The caterpillars commence eating the plants from above downwards, devouring the leaves and bark, until they come to where the bark begins to get fibrous, when they proceed to the next plant which they treat in similar manner, and when they have thus demolished the plants in one field they proceed to the next. The caterpillars carefully select the healthiest plants for attack, leaving stunted and withered plants untouched; they also spare the mature leaves of healthy plants.

"No endeavour on the part of the cultivators can save a field which is attacked by this pest.

"The attack lasts for from seven to fifteen days; about the fourth or fifth day of the attack, vast numbers of newly hatched caterpillars of the pest may usually be found on the underside of the leaves of some of the plants; these young insects spread themselves over the field, when they are about two or three days old, and they are even more voracious than the older caterpillars.

"After the caterpillars have left a jute field, little but stalks, stripped of leaves, shoots, and bark remain, and these stalks the cultivators cut and use for fuel.

"The pest has not appeared during the past year (1888-89) in Basirhat; in 1886-87, however, a few fields were injured by it, but the damage was too slight to affect the local market, while in 1873 serious damage was done by it to the jute crop throughout the greater portion of the sub-division, very few fields escaping attack.

"*Crickets.*—Amongst minor insect pests may be noticed *uchchuingra* (or crickets) which sometimes do damage in seasons of drought. These insects burrow in the ground and uproot the seedlings or destroy them by cutting through their roots. They disappear, as soon as a heavy shower of rain falls, and are not seen again for the rest of the season. If the drought, which is generally supposed to be the sole cause of the attack, be protracted, the pest sometimes does such serious injury that the fields have to be re-ploughed and sown with fresh seeds; this, however, rarely happens.

"*Jara or twisting.*—In seasons of protracted drought the *aus* paddy, and sometimes the jute plants, are visited by a kind of blight which is known in Basirhat, as *Jara* or twisting. This blight warps and twists the leaves and shoots of the paddy and jute plants, and thus arrests natural growth. The cultivators consider it to be a 'visitation of nature' and take no steps to remove it."

A Murshidabad report.

In a report (dated December 1888), received through the Director of Land Records and Agriculture, Bengal, the Deputy Collector of Jungipore (Murshidabad), reports on the following insects which have at different times proved injurious:—

"1. *Kora poka*—a white insect about an inch in length that lives under ground, and destroys the roots of paddy seedlings, wheat and rabi crops.

"2. An insect which 'appears on the leaves of rabi plants, when southern winds blow in the winter season, and dies away when the western winds blow.'

"3. An insect that appears before the paddy is ripe, in *Rarh* tracts, and cuts the leaves; it is also found in jute and *kalai* fields.

"4. *Gandhi poka*—which resembles a large gnat in size and appearance, sucks the juice of young paddy.

"5. *Bajarmari*—is black in colour and resembles No. 4; it appears in years of high floods and completely destroys paddy plants.

"6. *Bamani insect*—a round black insect of the size of a large pea; has similar habits to those of No. 5.

"7. *Faring fly*, with black body and red 'face,' attack paddy blades; when numerous they also destroy other plants and trees."

A Hazaribagh report.

The following is taken from a report,[1] dated 16th November 1888, by Baboo Adhar Kali Mukerjee, to the Deputy Commissioner of Hazaribagh, forwarded by the Director of Land Records and Agriculture, Bengal:—

"A caterpillar, due to excess of rain, which attacks the roots of *mokai* when the plants are from 4 to 6 inches high.

"A small green insect, due to excess of rain, that eats the stalks and leaves of *mokai*.

"*Gonderpilna*, a pest due to excess of rain, that eats the stalks and leaves of *mokai*.

"Two species of insects, one being a kind of fly, and the other known as *Chilna*, which are due to excess of rain, and which suck the undeveloped seeds of *marwa*, leaving only the husks.

"*Balwa*, a grub that eats up the young plants of *urid*.

"A green insect, due to excess of rain, which cuts the plants of *urid* when they are 3 or 4 inches high.

[1] In this report the same insect seems, in several instances, to have been described more than once.

"Two kinds of insects known respectively as *Gandhipilna* and *Lobipilna*, which destroy the flowers and pods of *ghangra*.

"*Lalpilna*, a red insect, due to cloudy weather, which eats up the seeds of *ghangra* when they are green and soft.

"*Gondhi* plants suffer from three different kinds of insects, all of which suck up the undeveloped seeds. The three insects are (*a*) a kind of fly due to excess of rain; (*b*) and (*c*) insects known respectively as *Chilna* and *gondhi*, which are due to excess of rain and heat.

"*Barai* plants suffer from four different kinds of insects, all of which eat up the leaves and cut the stalk. These insects are known as (*a*) *Balua*, (*b*) *Chornopilna*, (*c*) *Lalupilna*, (*d*) *Gandui*, which is a kind of fly, supposed to be due to excess of rain and heat.

"Three different kinds of flies all of which suck the undeveloped seeds, *viz.* (*a*) *Gandhi* which damages *gora* and *kodo* crops; (*b*) *Chilna* which attacks *gora* and *dighio* crops, and is supposed to be due to excess of rain and heat; (*c*) *Makhi*, which damages the *dighio* crop and is supposed to arise in grass.

"*Kharpuri*, a small green insect which attacks *dhan* plants, at the time of flowering, and causes them to wither.

"*Bohhi*, a white insect which eats up *dhan* plants.

"*Balna*, a red insect which eats up *kurthi* seeds, in cloudy weather, when they are green and soft.

"*Balna pilna*, a pest supposed to be due to excess of rain which destroys the green til pods.

"*Gandhi pilna*, a pest which arises in cloudy weather and destroys the flowers of *sarso*.

"*Lurka*, a green insect which eats up the grain of *boot* when it is green and soft in cloudy weather.

"*Balna*, a red insect which eats up the grain of *khasari*, when it is green and soft, in cloudy weather.

"*Kajra*, green, black and red insects which cut *pushta* plants, in cloudy weather, when they are 4 to 6 inches high.

"*White ants* known as *dewant* which are supposed to be due to dampness; they cut the roots of young *kitari* plants when less than 18 inches high.

"*Kijra*, a green insect which eats up the young plants of *gohum* and *jas* when they are about 6 inches high."

A Hazaribagh report.

The following is from a report dated 7th November 1888, from the Deputy Commissioner of Hazaribagh—

"1. *Gandhi Macchi.*—Attacks *gora* dhan and *badhian* dhan while the crop is in ear. It destroys up to twelve annas of the crop. This pest generally appears in the year in which the rains set in early, that is, in May.

"2. *Lahi keeda* and *Bhua keeda.*—Attack '*urid*,' '*baroi*,' and '*sim*,' when they are almost ready for being harvested, and destroy them completely.

"3. *Gandhi keeda* and *Bhogjogri keeda.*—Damage the leaves of *kohrah*, *ghangro*, and other creepers.

"4. *Banki keeda.*—Attacks the dhan plant, generally when it is transplanted late, and the transplantation is followed by heavy showers of rain."

Bankoora report.

The Collector of Bankoora (Mr. W. V. G. Taylor) in a report, dated 25th August 1888, writes:—

"The occurrence of an insect pest in the jurisdiction of police station Khatra, in the paddy fields of villages Ambicanagar, Kapradara, Banzilla, Darsole and Huridraban

covering an area of about 13 square miles, of which about 1 square mile has been affected by a species of insect locally called *Nali poka*, which has been eating up the leaves of young rice plants. These insects are now in their caterpillar stage.

"The Sudder Police Inspector reports that these insects would have eaten up the leaves of the plant in the course of a fortnight had there been no rain for some time. But as heavy and continuous rain has lately fallen in that part of the district, there is no longer any cause for apprehending further damage by these insects. The cultivators say that excessive rainfall in the latter half of the month of Joisto (May), followed by drought or slight rain in Asar (June) is the cause of their origin. It is supposed that the rains of Joisto (May), decomposed all dead vegetable matters from which the insects take their birth, at first in the shape of eggs, but if there are heavy showers of rain so as to wash away all putrid substances, the eggs are destroyed and caterpillars, such as are sent, appear. They do not form cocoons."

Chota Nagpore report.

Extract from a report, dated 26th October, from the Commissioner of Chota Nagpore (Mr. C. C. Stevens) :—

"1. *Caterpillar.*—This is the only insect pest, which so far as the Singbhoom authorities have been yet able to ascertain, which infests agriculture in that district. It is described by them as 'small, hairy black or dark colored,' and locally known by the name of 'Lehobari.' It attacks the young *dhan* plants in seasons in which there is insufficient rainfall and when in consequence much heat and dryness prevail; it cannot stand exposure to water, and eats up the tender leaves of the *dhan* seedlings only down to the level of the water. The Manager of the Dhulbhoom Estate says that the caterpillar undergoes a series of metamorphoses similar to the tussar or silkworms. It wraps itself gradually up on the leaf it preys upon, and is there changed into a chrysalid or cocoon of a shining black color.

"2. Caterpillars are also known to the Loharduggah and Giridih ryots. The Manager of the Chota Nagpore Raj classifies them into three varieties, and the Sub-Divisional Officer of Giridih speaks of two. Those mentioned by the former are the following :—

"(*a*) That of a black color found in *Burwa*, known by the name of *Nandana Sellava*. It chiefly prevails during the rains, though sometimes in the cold season also. It feeds on all crops and grasses, and is said to be poisonous in its bite, and if trodden on causes sores on the feet. It is of the size of the Bhowa insect. The Manager promises to send samples, if desirable.

"(*b*) That of a yellow color, known as '*Boosa*' caterpillar. It is much the same as variety (*a*): it attacks '*murwa*,' '*borai*,' and cotton plants; it does not cause sores on the feet. There is no remedy known for it.

"(*c*) That of a green color, about one inch long, and called '*Sarka*' caterpillar. '*Mustard*' *sorsa* and *lotui* crops are specially affected by it.

"The varieties mentioned by the Giridih authorities are—

"(*a*) The *Loorka pillu* which gets below the soil and attacks the young paddy and makai plants, severing them just at the junction between stem and root; sometimes attacking grain plants also, and is otherwise known by the name of '*Chirva*.'

"(*b*) Another, of which the local name is not given, eats away the pistil of the female flowers of the makai before the virules are fertilized, and the seed stalks grow up without a single grain.

"6. The names of the other insect pests, with their habits and remedies, if any, for their eradication, are shown below, the information being supplied by the Sub-Divisional Officer of Giridih.

"*Poonchi*—Attacks paddy seedlings before they are transplanted and destroys all the leaves.

"*Kuttra* or *Pahin* and the *Hurra pillua* (Green Worm)—Attacks the tender leaves of the dhan and makai respectively, and weaken the plants considerably.

"*Kujra*—Attacks the dhan, if there is cloudy weather just as the ears are forming, and severs them.

"*Mukhi*—Attacks the young grains of dhan and marwa, sucks up the milk and leaves only the husk.

"*Gundhi*—Impregnates the grains of murwa on which it happens to sit with the substance which emits the disagreeable odour, for which the insect is notorious, and the grains have a nasty smell and assume a shrivelled appearance.

"*Bulua*—Attacks the young grains of *kurthi*, *khesiari*, *chena*, *urid*, *masoor* and *moong*, and destroys them completely.

"*Lahee* or *Boorhia pillua*—A red fly which attacks mustard plants and vegetables such as *khisa* and *jhinga* and destroys them completely.

"*Tiddi*, or locust, is rare, but not unknown.

"The above, the Giridih officer says, are all visible, but there is a disease in dhan plants known as *Aren* or *Bhinks*; it attacks the plants when in ear and is supposed by many to be caused by a small insect inside the stalk."

The following information has been supplied by the Manager of Chota Nagpur Raj:—

"*Bauku*—Affects both planted and sown dhan (rice), particularly if sown late; rice affected turns white and dies. Insect surrounds itself with leaves and makes a pipe in which it lives. The preventive measure adopted by ryots is good—early cultivation and keeping fields moist; if they do occur in early crop, they flood it and try to drown them and beat them off the plants into water.

"Flies or (*Makkhi*)—Of different kinds said to drink the milk of corn forming. To prevent this, ryots put branches of trees in their fields to attract birds to rest and then to eat the flies.

"*Hardak* or *Gowrab*—Attack the wheat, *hardak* is said to attack it when yellow, and *gowrab* when it is red.

"*Ghangra*—Green color, $\frac{1}{2}$ inch long, found in gram and *kesari* pulse.

"*Lakee*—Small flies; occur in rains; attack '*sarso*,' '*lotin*,' '*rahr*' and dry them up.

"*Black and red ants*—Are injurious to silk cultivation."

The Manager says that any further information, or specimens of any of these can be provided if required.

A Chota Nagpore report.

The following extract is taken from a report, dated 29th October 1888, by the Sub-Divisional Officer of Palamow, Lohurdugga, Chota Nagpore, forwarded by the Director of Land Records and Agriculture, Bengal. The report notices that, of all the insects mentioned in the list, the locusts are the most injurious, totally destroying the crops on which they settle:—

"1. *Lahi*—A kind of black insect; does great mischief to mustard and *barai*.

"2. *Tidi*—(Locusts) are of various kinds of different size and color, the biggest are about 3 or 4 inches in length. They are rarely seen, but whenever they appear in great numbers they totally destroy the crops on which they settle. The smaller ones

are generally found here, but they do not make a wholesale destruction of any crop; the locusts generally feed on dhan, sugarcane, cotton, mangoes, &c.

"3. *Chatter*—A kind of wingless insect, with a red head, but the body is grey. It materially injures the dhan and makai crop. It is generally found inside the plants.

"4. *Bhooa* (caterpillars) are of various kinds and of different colours; destroy *til*, wheat and dhan.

"5. *Khaira*—A kind of red insect; does great mischief to dhan.

"6. *Balooi*—A kind of small wingless red insect; which eats up the seeds of *rahur*, *kurthi*, *barai* and *bodi*, &c.

"7. *Gadahia*—A kind of small-winged and flat insect; eats up the roots of barley and wheat in Kartic (October), when they begin to shoot up."

"8. *Gerooi*—A kind of red insect.

"9. *Hurda*—A kind of green insect; destroys barley and wheat in Falgoon (February) and Chait (March).

"10. *Ghagra*—A kind of green insect; is found in the capsules of the gram plants in Falgoon (February), when they begin to blossom, and does material injury.

"11. *Banki*—A kind of small (white or green) creeping worm; destroys the dhan plants in Sravan (July), Bhado (August) and Asin (September) by eating away the stalk and the leaves.

"12. *Katur*—A kind of winged insect (like a grasshopper), about half an inch long; destroys the stalks of wheat and barley.

"13. *Jhasi*—A kind of small, black, wingless insect; destroys both kinds of *til* by eating away the leaves and the stalks.

"14. *Phatangi*—A kind of worm; lays eggs and dies soon after; from the eggs are born worms called *Nandua*, which creep over the ground and do great mischief to *dhan*, *marooa*, *gondli*, &c.

"15. *Karup*—A kind of small green worm; is born during the winter season and destroys the rabi crop.

"16. *Bhoodli*—A kind of big worm, with red head; destroys *bodi*, *barai*, and *urid* by eating away the leaves.

"17. *Gadhi*—A kind of green creeping fly; sucks up the juice of dhan plants.

"18. *Jhinjhoor* destroys the roots of barley and wheat plants.

"19. *Bala*—A kind of small green wingless worm; is found in the capsules of *gram*, *peas*, *khesari* and *masoori*.

"20. *Jharni*—A kind of green worm about an inch long and thin, like a thread; does much mischief to *Bhadri* crop.

"21. *Toonki*—A kind of grey worm, about half an inch long; destroys the ears of dhan.

"22. *Phinga*—A kind of worm of brown colour about quarter of an inch long; destroys the leaves of wheat and barley plants."

A Noakhally report.

The following is from a report, dated Dalalbazar, 12th August 1888, by Baboo Chandra Roy, to the Collector of Noakhally, forwarded by the Collector of Chittagong through the Director of Land Records and Agriculture, Bengal:—

"1. *Mahooah*—Color green; winged, having trunk; injures nearly ¼ crops when the corn issuing from the stem remains like milk in its kernel stage; not available at present time, but in October when the corn is nearly matured.

"2. *Shonamukhi*—Color black; one-fourth inch in length; injures the leaves and stem of the plants in Ashar and Sraban (July and August). Almost half the crops are damaged by it.

"3. *Tutia*—Color black; ⅛th inch in length; is seen in Ashar and Sraban (July

and August); injures the leaves and stems of the plants, and thus causes destruction of whole and sometimes half of them.

"4. *Maija*—Color white; face red, no wings; ½ inch in length; originates in field; injures the stem in Ashar and Sraban (July and August); when these insects attack any field they make damages to almost all the crops.

"5. *Sani*—Color brown; winged; length one inch; injures the bunch of corn in Agrahayan and Pous (November and December).

"6. *Arangi*—Body black; face red; breast white; 1½ inch in length; injures the stalk and stem of the corn in Agrahayan and Pous (November and December); sometimes a quarter to three-eighths of the crop is damaged by it.

"7. *Leda*—Color whitish; face black; no wings; originates in field; injures the stalk of paddy leaves of *capsicum, brinjal, bean, pea, gourd* (*kumra*), and a stalk-like plant called (*data*), &c.

"8. *Large Gandhi*—Color black; shape round; having bad smell in its body; causes inflammation if any one touches it, injures bean, pea, cucumber, gourd (kumra), leaves of brinjal, &c.

"9. *Small Gandhi.*—Color red, spotted with black; smaller in size than the former one; damages the plants mentioned above.

"10. *Karipoka*—Color green; winged; injures cucumber, gourd, &c."

A Balasore report.

The following is an extract from a letter from Baboo Kailash Chandra Rai, of Dihurda, dated 17th August 1888, to the Collector, Balasore, forwarded by the Director of Land Records and Agriculture, Bengal—

"At present I beg leave to draw your attention to two sorts of insects. One of them is '*Mulia poka*,' or insect destroying the root. This '*Mulia poka*' is a great pest of the young paddy plants. It comes into existence when there is drought or scanty rain, and destroys most of the plants of the field. It disappears or dies when rain begins to fall copiously. But the plants injured by the pest become rotten and fall down as the rain water increases. Fields infested by the '*Mulia*' insect do not produce good crops, although resown with much care afterwards. Some people burn the straw that remains in the field after the crop is gathered, with a belief that such burning checks the pest of the '*Mulia*' insect, but it is difficult to say how far the remedy is effective. Specimens of these insects cannot be had at present, as they are all gone under water."

A Monghyr report.

The following extract is taken from a report dated 6th December 1888, forwarded by the Collector of Monghyr:—

"1. The most terrible pest of crops here is an insect called *Kajra* which eats up not only paddy, but also all the rabi crops. It is a snail-like animal, about two or three inches long, and is of a dark complexion. The similar, but smaller, species is called *Larka*, which eats up rabi crops. The *Bhua*, or caterpillar, is well known. There are three species of this insect, red, black and white, which appear whenever there are clouds and fogs in November or December, and devastate the rabi crops; but if there be any heavy shower they generally die and disappear, and the crops are saved. *Lahi*, a kind of small insect, is very injurious to rabi crops, especially to mustard. There is a Dhoosur-colored (earth-colored) insect called, *Gadhya* or *Kutooa keera*, which does much harm to the *Aghany* paddy by cutting the ears of the crop. The *Babhui*, which is of the size of a large fly, devastates the paddy.

"2. These are all the important insects which are injurious to crops, and their action is substantially the same. They eat up the green of the plants, leaving the stem to wither. They are generally met with when the weather is cloudy and there is no rain, and they disappear with a heavy shower. It would be conferring a great blessing on the agricultural population and men in general if, from studies of insect life, measures can be adopted to prevent their inroads."

Report by Raja Durga Charan Law, C.I.E.

The following is taken from a letter, dated 26th September 1888, addressed to the Collector of the 24-Pergunnahs by Rája Durga Charan Law, C.I.E.: specimens illustrative of Nos. 1 and 2 were forwarded to the Museum, but arrived in too bad condition to make anything of:—

"1. In Midnapore a pest known as '*Jot kati*' eats up the leaves of plants.

"2. In Nudea Dihi a pest known as '*ancha*' destroys the leaves and stalks of jute crops.

"3. In Khoolna a pest known as '*Pamuri*' infests the growing stalks of (rice?); its increase is favoured by cloudy weather.

"4. A pest known as '*Katra*,' which has some resemblance to a small crab; infests paddy seedlings, sucking up the juice of the leaves.

"5. A pest known as '*Lada*,' a grub which cuts the paddy stalks when the grain is ripe.

"6. A pest which bores into growing paddy stalks, and is very destructive."

Report on a paddy insect.

In a letter dated 2nd September 1888, forwarded by the Officiating Collector, 24-Pergunnahs, Baboo Koonja Lal Mookerjee, the manager to the estate of the late Raja Degumber Mitter, C.S.I., notes as destructive to paddy in Backergunge, an insect known as '*Mazra*.' He writes that the insects are "very small in size, not easily perceived by the naked eye; they grow in the joints of the paddy plants and destroy them very soon." He also notices an insect known as '*Nedú*,' which is found in the ripe paddy in October and November, and cuts off the ears of the paddy. The pest appears chiefly in cloudy weather when the rainfall is insufficient.

Report on a makai pest.

In a letter dated 25th August 1888, from the Magistrate of Durbhunga, a pest is noticed as injurious to the makai crop; it is said to be a sort of cricket, locally known as *Bheriá*.

A Burma report.

In a report dated 8th October 1888, forwarded by the Director of Land Records and Agriculture, Burma, is noticed a hairy caterpillar which attacks rice and maize in July and August, sometimes destroying as much as half the crop.

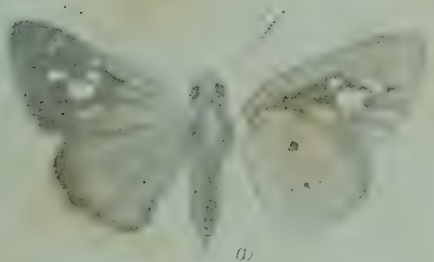
Government of India Central Printing Office.—No. 632 R. & A.—13-6-89.—1,000.

a

b

THE RICE SAPPER.

Leptocorisa acuta, Thumb

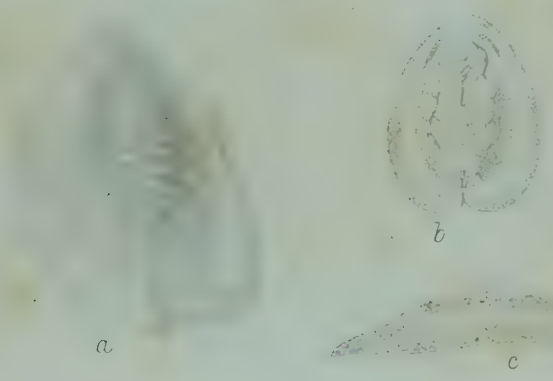


a

b c

4. Suastus gremius, Fabr.

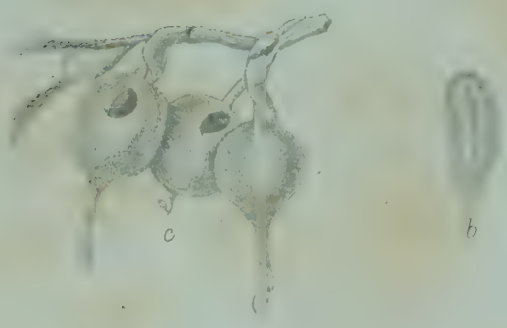
2. Ceratophis, Sp.



a b c

3. Lecanium acuminatum, Sign.

a



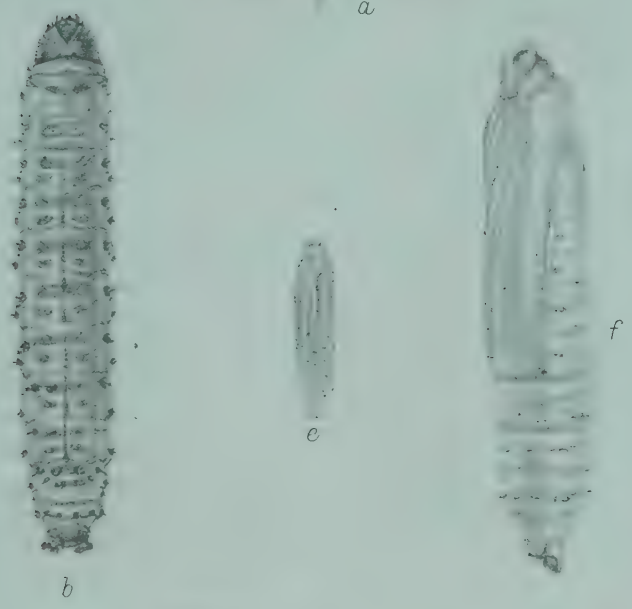
c b

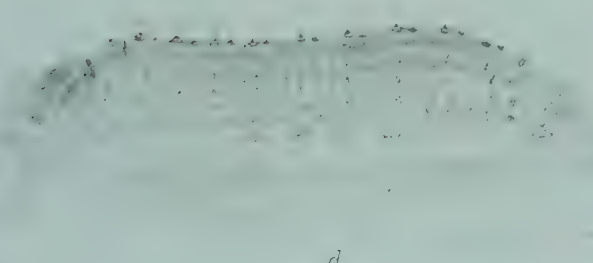
5. CARDAMOM PEST.

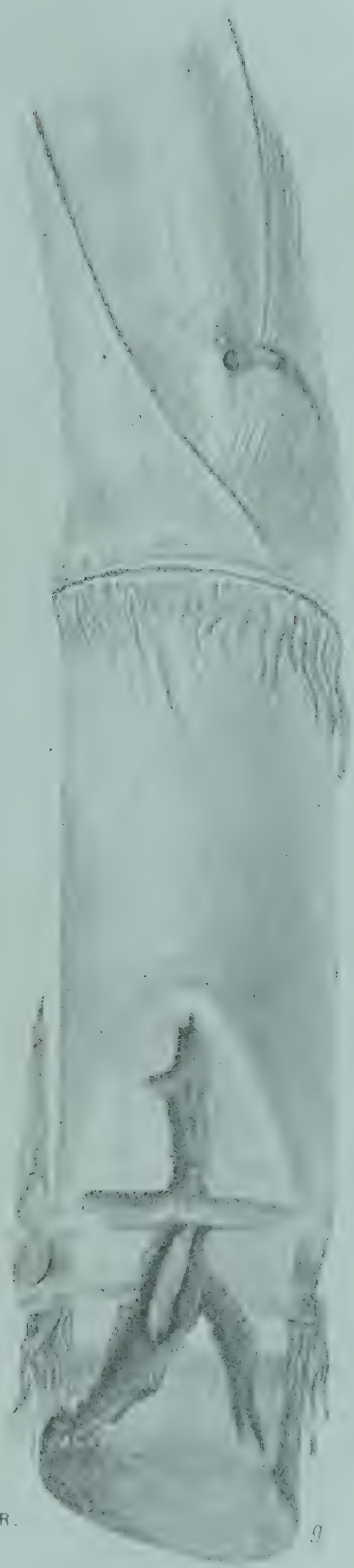
Lampides elpis, Godart

Photo-etching from the original pencil Drawings-Survey of India Offices, Calcutta, April 1883.

1. THE BENGAL RICE HISPA.
Hispa aenescens, Baly.



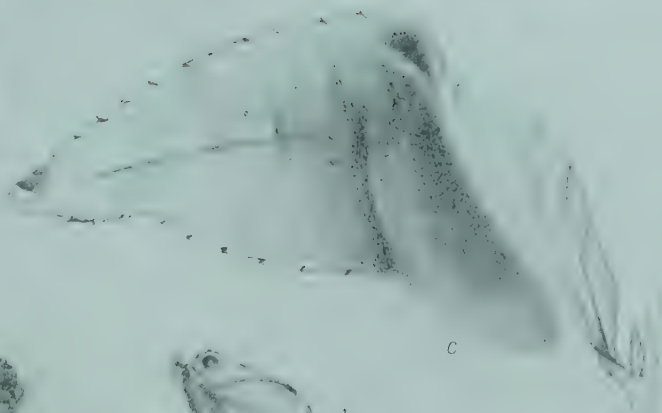


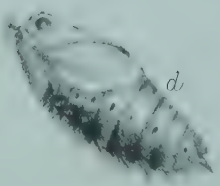


2. THE SUGAR CANE BORER.
Diatraea saccharalis, Fabr.

Ch. Chuckra butty, del

Photo-etching from the original pencil Drawings-Survey of India Offices, Calcutta, April 1889.

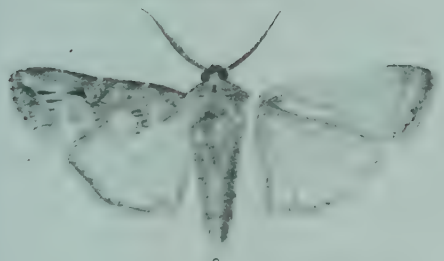


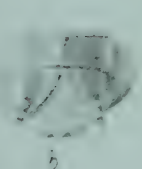


1 TEA AND SAL PEST

Dasychira Thwaitesii, Moore.

(with parasites.)





2 CUT WORM

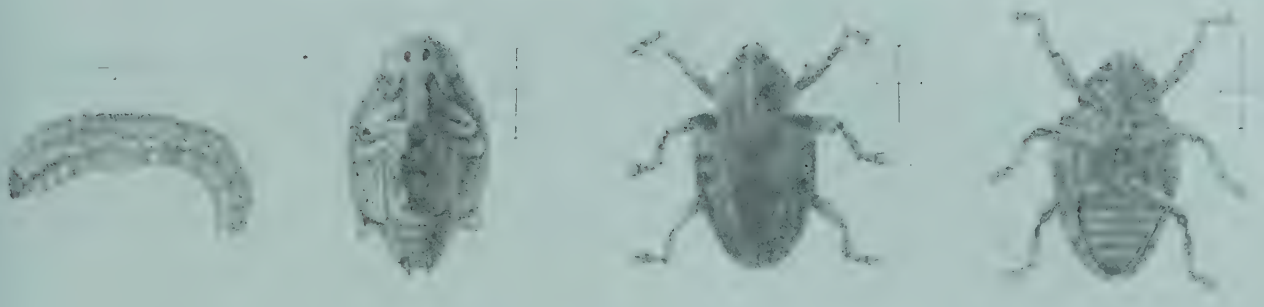
Agrotis suffusa, Hübn.

3 CEDRELA PEST

Magiria robusta, Moore.

Ch. Chuckra butty del

Photo etching from the original pencil Drawings Survey of India Offices, Calcutta, February 1889



1 THE MANGO WEEVIL
Cryptorhynchus mangiferae, Fabr.

2. Dermestes vulpinus, Fabr.

3 FORCE PUMP

4. CYCLONE NOZZLES.

eli Ch. Chuckra. butty, del.

Photo-etching from the original pencil Drawings-Survey of India Offices, Calcutta, April 1889.

NOTICE.

THE serial *Indian Museum Notes,* issued by the Trustees of the Indian Museum, Calcutta, under the authority of the Government of India, Revenue and Agricultural Department, is to take the place of *Notes on Economic Entomology*, of which two numbers have appeared.

The parts of the serial will be published from time to time as materials accumulate. Communications are invited; they should be written on one side only of the paper and addressed to—

The Editor,
Indian Museum Notes,
Calcutta.

Correspondence connected with Economic Entomology should be accompanied by specimens of the insects to which reference is made. Caterpillars, grubs, and other soft-bodied insects can be sent in alcohol; chrysalids and cocoons, alive, and packed lightly in leaves or grass; other insects, dried and pinned or wrapped in soft paper. Live insects should be sent when there is a reasonable probability of their surviving the journey. Caterpillars, grubs, and other immature insects can often be only approximately determined; they should therefore, where possible, be accompanied by specimens of the mature insects into which they transform; when, however, this is not possible, they should still be sent, as they can always be determined approximately, and uncertainty must necessarily arise in discussing insects when actual reference to the specimens cannot be made.

The papers in the second number of *Indian Museum Notes* deal with Indian Economic Entomology, and are based on material which has been sent to the Indian Museum by the Government of India, Revenue and Agricultural Department, by the Departments of Agriculture in the various local Governments, by the Forest Department, and also by private individuals in different parts of India. For the views expressed the authors of the respective *Notes* are alone responsible.

THE EDITOR.

INDIAN MUSEUM,
CALCUTTA:
The 21st June 1889.

NOTES ON INDIAN ECONOMIC ENTOMOLOGY.

AN UNPUBLISHED PAPER BY THE LATE DR. E. BECHER.

Translated from the German by E. C. COTES.

I.—TRYCOLYGA BOMBYCIS.[1]

[*Plate V, fig. 1.*]

Caput flavide nitens, fascia frontali nigra, occiput pilis canis longis praeditum; oculi hirti; antennæ nigro-brunneæ; antennarum articulis tertius plus quam duplo longior secundo; palpi brunnei, in basi nigri, thorax cinereoflavus quinque fasciis nigris fere æqua latitudine ornatus, quarum media antice inconspicua, thoracis latera cana, albide nitentia; scutellum fulvum, in basi nigrescens, setis quatuor longis in margine præditum; abdomen nigrum, segmenta singula, primo nigro excepto, antice fasciis latis albide flavescentibus, linea dorsali nigra; macrochetis marginalibus duabus in segmento primo et secundo, discoidalibus nullis; alæ fere vitreæ; squamæ albida-flavescentes, permagnæ; pedes nigri, femora albide nitentia.

Head in both sexes as broad as the thorax; the lower portion of the clypeus retracted, parts round the mouth but little prominent, whitish in colour, mouth bristles (*vibrissæ*) situated somewhat above the mouth on the sides of the clypeus; facial bristles (that is to say, the bristles situated above the mouth bristles) weak and short, not reaching as far as the middle of the clypeus, but approaching the bristles, which droop from the upper part of the head, genæ broad, of yellowish hue, not covered with fine bristles, but only having a few bristles drooping from above (there being five of these bristles in the male and three in the female), lateral portion of the clypeus about half the breadth of the eye, hairy, of whitish colour, forehead somewhat prominent, and occupying about a quarter of the breadth of the head in the male and a third of the breadth in the

[1] Becher described this insect as *Trycolyga bombycum*, nov. sp.; it has, however, already been discussed by Louis (*A few words on Sericulture in Bengal, 1880*), also by Cleghorn (*Note on the Natural History of the Bengal Silk-worm Fly in the Rajshahye District, 1887*) under the name of *Œstrus bombycis*: the name *Trycolyga bombycis* seems, therefore, the best to adopt, as the insect has no connection with the genus *Œstrus*,—*E. C. C.*

female ; in the male the borders of the forehead converge very markedly towards the vertex of the head, while in the female they are almost parallel. There are three bristles situated above the bristles on the genæ ; stripe on the forehead is smoky black ; sides of the forehead, and ocellus patch, are yellowish, the latter being a little the darker; eyes very thickly covered with prominent hairs ; antennæ blackish brown at the base, appressed, the first joint short, the second somewhat produced, the third more than twice as long as the second with a sharp angle on the underside of the anterior portion, the hinder angle being rounded off ; the antennal bristle two-jointed, naked ; proboscis somewhat prominent, palpi almost cyclindrical, but somewhat narrowed in front, the color yellowish brown with a darker base.

Dorsal thoracic shield yellowish grey, with four, almost equally broad, blackish longitudinal streaks, which nearly reach the scutellum behind, also a fifth similar streak, which becomes distinct on the transverse suture and runs quite up to the scutellum ; the inner paired streaks are somewhat narrower than the outer ; the sternal aspect of the thorax is grey with white sheen ; the dorsal aspect and sides are thickly covered with hairs.

The scutellum is brownish with black base and yellowish grey sheen ; on its outer edge are four long bristles.

The abdomen, which consists of four segments, is produced—oval in outline ; the first segment is black ; each of the following segments has a central black stripe forming a continuous line, and in front a broad yellowish white glistening connecting membrane ; genitalia, in the male, are black with reddish brown bristles at the extremity ; the ventral aspect of the abdomen is blackish grey with narrow black connecting membranes ; the sides of the second and third segments of the abdomen are of a reddish brown ground colour. There are two stout bristles on each of the first and second segments of the abdomen ; three pairs of long stout bristles on the edge of the third segment, one pair being situated on the upper surface and one pair on each side ; the posterior segment is thickly covered with hair and bristles.

Wings vitreous, proportionately of large size, without any marginal projection, the first posterior marginal cell, directed towards the apex of the wing, is open ; the fourth cell bends towards the third either along its whole length or at one corner only, without further appendage of veins, but with a wing fold that resembles a vein ; the apical transverse vein is somewhat bent in towards the posterior marginal cell ; the posterior transverse vein is slightly-s-shaped near the bend in the fourth longitudinal vein ; the second longitudinal vein has several bristles at the base ; the fifth longitudinal vein is distinctly wavy where it approaches the margin of the wing ; the sixth vein is much bent and does not reach

the margin. The alulæ are large and bluntly lancet-shaped; the valvæ are very large, in colour grey with yellowish margin.

Legs black; femora of greyish hue; femur of the front leg, on the outer side thickly covered with short hairs, on the inner side, both above and below, with rows of long bristles, the upper ones being less closely set than the lower ones; the femora of the middle and hind pairs of legs are thickly covered with hair, and also have a few large bristles. Tibiæ, besides short hairs, have some scattered bristles, which are most numerous in the hind pair of legs; in the middle pair of legs the tibia has two spine-like bristles at its extremity. Tarsi are covered with bristles; metatarsus is almost as long as the rest of the tarsal joints together, terminal tarsal joint is club-shaped; the male has large pulvelli, the female smaller ones; the claws are long and powerful, and have long slender bristles between them.

Length of body, in specimens taken from *Bombyx fortunatus* (or *Desi*), ranges in the male from 10·5 to 12 millimetres, and in the female from 8·5 to 11 millimetres: while in the specimens taken from *Attacus ricini* the length ranges in the male from 12 to 13·5 millimetres and in the female from 11 to 12 millimetres.

The flies taken from Maldah specimens of *Bombyx fortunatus* and also those from Dinajpore specimens of *Attacus ricini* belong to the same species; they differ from each other in their size, which depends on that of the host, and in the yellow colour, on the heads of the males taken from *Attacus ricini* being somewhat brighter than in the males from *Bombyx fortunatus*. *Trycolyga bombycis* is distinct from the dipterous parasite *Tachina oudji*, Guérin (Comptes Rendus, LXX, 1870, p. 844) = *Udschimyia sericariæ*, Rondani (Cornalia, Bull Soc. Entom. Ital., II, 1870, p. 137), which attacks the silk-worm *Bombyx mori* in Japan: the two species may be distinguished by the fact that in *Trycolyga bombycis* the eyes are thickly covered with hair, and the abdomen is longer and more slender than in the Japan species. *Trycolyga bombycis* is very closely allied to the parasite *Exorista leucaniæ*, Kirk. var. *cecropiæ*, Riley (Ann. Rep. on the nox. benef. Insects of Missouri, II, p. 50), which attacks the American silk-worms *Attacus cecropiæ* and *A. polyphemus*. About the latter parasite Riley writes (*loc. cit.* IV, p. 108, 1872)—

"The larvæ of this Tachina fly, which is also parasitic on the Cecropia worm, seem to produce an undue and unnatural growth of their victim. In the beginning of September 1866 I received an enormous Cecropia worm. It measured over 4 inches, was a full inch in diameter and weighed nearly 2 ounces, but, like many other large specimens which I have seen since, it was covered with small oval opaque white egg shells, clusters of four or five occurring on the back of each segment, invariably deposited in a transverse direction. The skin of the worm was black where the young parasites had hatched and penetrated. This large worm soon died and rotted, and in about twelve days a host of maggots gnawed their way through the putrid skin. These maggots averaged about one half inch in length, and in form

were like those of the common blow-fly. The head was attenuated and retractile and furnished with two minute curved hooks, and the last segment was squarely cut off, slightly concave, and with the usual two spiracles or breathing holes which this class of larvæ have at their tails.....They went into the ground and remained in the larva state all the winter, contracted to pupæ in the April following and the flies commenced to issue the last of May."[1]

II.—CHALCIS CRICULÆ, *nov. sp., Kohl.*

[*Plate V, fig. 2.*]

Mas: nigra alæ limpidæ; Femora postica rufo apice albido flava; caput et thorax subpunctata; facies deplanata; antennæ crassiculæ, apice externo flavido; scutellum convexum inerme.

Comparing this species with the palæarctic *Chalcis podagrica*, Fabr. The head, which is black and slightly punctated, is similar except in having a smooth clypeus. Flabellum of antenna is somewhat slighter, the apex of the terminal joint being light yellow. The punctation on the head and sternum is less marked. On the scutellum the punctation is clearer and coarser than on the mesothorax, but on both it is so scattered that it gives the whole thorax the appearance of being distinctly more glossy than in most species of the genus *Chalcis*. The scutellum, which is not produced posteriorly, is unarmed and arched. The legs are slighter than in *podagrica* and are in proportion to the smaller size of the whole insect and its slighter antennæ. The extremities of the femora, tibiæ and tarsi of the two anterior pairs of legs are yellowish white, tinged in places with dull yellow. In the posterior pair of legs the femur is red with pale yellow extremity, and has from twelve to fourteen spines, which are smaller and more evenly arranged than in *podagrica*. The wings are vitreous. Length of the insect is

[1] Dr. Becher adds a note on the Uji Fly, whose life history he believed to be similar to that of *Trycolyga bombycis*. Apparently, however, he had only seen Sasaki's preliminary notice of his investigations on the subject (*Nature*, XXX, p. 436), and the life history as described by Sasaki was so anomalous that Dr. Becher rejected it as altogether improbable, adopting instead the older theory which, however, appears to have been based on little more than supposition. Sasaki has since published (Journ. Coll. Sci. Tokyo, Japan, Vol. I, 1886) an elaborate memoir on the subject, and seems fully to have established his observations, which show that this interesting species has a life history very different from that of *Trycolyga bombycis*. According to Sasaki the fly deposits its eggs, which are very small, on the underside of mulberry leaves. The silk-worms, in eating these leaves, swallow the eggs, without crushing them with their mandibles. The egg hatches in the digestive canal of the silk-worm, the maggot thence forces its way through the wall of the digestive canal into one of the nerve centres which lie below; here it remains, feeding upon the nerve cells and growing, until the membrane of the ganglion ruptures and the maggot passes into the body cavity. It then makes its way to the main trachea of one of the stigmata and fixes itself, with its head in the body cavity and its posterior stigmata in connection with one of the stigmata of its host. In this position it is enabled to respire and remains until full grown. The affected stigma of the silk-worm is easily recognized by the brown patch which surrounds it. When full fed the maggot cuts its way out of the body of its host and betakes itself to earth, where it pupates.—*E. C. C.*

four millimetres. The type specimen was parasitic upon a species of *Cricula* obtained in Ranchi.

Explanation of the figures.

Plate V, fig. 1, Trycolyga bombycis; a, *imago enlarged;* b, *imago nat. size;* c, ♀ *head in profile enlarged;* d, ♂ *head in profile enlarged;* e, *puparium nat. size;* f, *imago emerging from puparium;* g, *larvæ nat. size.*

Plate V, fig. 2, Chalcis criculæ; a, *imago nat. size;* b, *imago enlarged.*

ENTOMOLOGY NOTES

BY

E. C. COTES.

I.—TRYCOLYGA BOMBYCIS,

The Bengal Silk-worm Fly.

[*Plate V, fig. 1.*]

Sources of information.

A technical description of *Trycolyga bombycis* by the late Dr. E. Becher is given on page 77. The economic side of the subject has been dealt with in the following papers:—

1. A few notes on Sericulture in Bengal by J. A. H. Louis (1880).
2. Notes on the natural history of the Bengal silk-worm fly in the Rajshahye district by James Cleghorn, 1887 (published by the Government of Bengal).
3. A letter by Nitya Gopal Mukerji, dated 7th October 1887 (published by the Government of Bengal).
4. Report of a meeting held in Berhampore on 12th November 1887, by Nitya Gopal Mukerji (published by the Government of Bengal).
5. A letter by C. W. Marshall, dated Berhampore, 20th July 1888 (published in *The Asian*).

In the present note, which is a summary of what has been ascertained, much has been taken from Cleghorn's paper, which is a valuable record of a very complete series of observations on the life history of the insect.

Extent of the injury.

The Bengal silk-worm fly causes considerable loss to silk-rearers in Bengal, but somewhat contradictory statements have been made as to the extent of the evil.

Marshall notices that the fly causes "enormous loss every year." Louis estimates this loss in Bengal at between £200,000 and £300,000 annually. Cleghorn notices a loss of five lakhs of rupees in a single crop, as indirectly due to fly. Mukerji recounts how the fly destroyed 90 per cent. of a lot of silk-worms he attempted to rear in Berhampore, while his two village nurseries, which might have been expected to yield 40 *khaons* each if the fly could have been kept off, produced only 8½

and 3½ *khaons* respectively. In this case, however, the loss does not appear to have been caused by fly alone, for muscardine was also present.

On the other hand, Mukerji states that the regular cocoon bunds in the villages do not suffer much from flies; and if this is the case some of the preceding estimates must be excessive. Where so many causes are at work to affect the outturn of a crop, exact estimates of the actual loss occasioned by the fly are no doubt difficult to obtain, and estimates, based on the amount of injury, done by the fly to small experimental rearings are likely to be excessive, as it is just the small rearings which suffer most. Taking everything into consideration, however, we may conclude that the pest is a real and serious evil, though perhaps not such a deadly one as some have been inclined to suppose.

Life history.

The Bengal silk-worm fly is much like a big house-fly, but its great wing power makes its capture particularly difficult. In Rajshahye it is found about rearing rooms and silk stores all the year round, but it greatly increases in number during the months of July, August, and September. It attacks the common Bengal mulberry worm (*Bombyx*), the eri worm (*Attacus ricini*), and is also supposed to be the species which was found to be parasitic upon the caterpillar *Dasychira thwaitesii*, a pest which has been known to do much injury in the Doars by defoliating *tea* and *sâl* (see Indian Museum Notes, I (1), page 31).

Copulation takes place in the air, one male fertilizing several females. The impregnated female is very active and persistent in her efforts to get at the worms, and once having reached a rearing tray, she will wander all over it, depositing an egg here and an egg there indiscriminately on the worms. The act of oviposition is rapid, and the fly simply glues her minute egg into the worm's skin with her ovipositor without making an incision. She moves under and about the leaves and stems on the tray, sometimes even ovipositing from below on to the ventral surface of a worm. When she suspects danger she conceals herself amongst the leaves and escapes from one part of the tray to another, so that an hour may sometimes be spent in endeavouring to dislodge her from a single tray. According to Louis two or three dozen flies are sufficient to destroy a whole roomful of worms. A silk-worm is only capable of nourishing about four maggots, but if there is a scarcity of worms the flies will lay many more than this number of eggs upon one caterpillar. Cleghorn found that the fly survived for about four or five days in confinement, but he is of opinion that it usually lives about eight days.

When freshly laid, the egg has a hard white shell that can just be seen with the naked eye. About fifteen hours after the egg is deposited, it hatches, and the maggot penetrates the skin of the worm. Cleghorn found that worms, which moulted within fourteen hours of having eggs

deposited upon them, escaped puncture by the maggots; while those which moulted later were more or less punctured. The opening made by the maggot, in penetrating into the body of the worm, does not close up, but becomes the entrance of a tube lined with a hard dark-colored substance. This tube is small at the entrance, where it perforates the skin of the worm, but increases in size internally to correspond with the gradual growth of the maggot. It is curved a short distance from the entrance, and expands like a bell where it is filled up with the posterior truncate extremity of the maggot. Beyond the bell-shaped expansion, the hard lining of the tube is continued by a soft gristly substance, which envelopes the body of the maggot, so that it is only the maggot's head which projects into the actual tissues of the silk-worm. The stigmata of the maggot are situated, as is usual in dipterous larvæ, at the posterior extremity of the body; and the maggot breathes air, which enters by the bell-shaped passage. When full fed, the maggot is much like a large grain of boiled rice, except that it is pointed at the head, and truncate at the posterior extremity, which is of about the same thickess as the middle of the body. It is armed with a long pair of thin mandibles, which are slightly hooked at the ends, and are hard and powerful. The body is ten-jointed, the skin remarkably tough. After living for about seven days inside the silk-worm the maggot becomes full fed and cuts its way out. The presence of the grub is indicated on the silk-worm by a black spot, which increases in size day by day, though the silk-worm continues to feed as usual, and even spins a cocoon, if it was not parasitised before the last days of the fifth month. A fly-blown worm spins about two days earlier than it would do when healthy, and it produces a very inferior cocoon. In cases where a cocoon has been spun the maggot forces its way through both chrysalis and cocoon, destroying the chrysalis and rendering the cocoon useless for reeling. After freeing itself from its host the maggot crawls away, and tries to reach the ground; if it succeeds in its endeavours and can find a soft place, it buries itself about an inch deep in the ground, and transforms into a pupa enclosed in the larval skin, which dries and hardens so as to form a case. About six hours elapse between its leaving the body of its host and transforming into a pupa; and if in this time it fails to find a place to bury itself, it pupates in the open.

The pupæ that were observed by Cleghorn rested about 12 days before producing imagos. The imago breaks through the anterior end of the puparium, by expanding the membrane of the front part of its head, exactly as Sasaki describes to be the case with the Uji Fly of Japan, and emerges as a fly ready to commence the cycle of existence that has been traced above.

The whole life of the insect, from the laying of the egg to the death

of the fly, after depositing its own eggs, may thus be comprised within about twenty-eight days, made up as follows :—

1	day passed in the egg.
7	days „ as a maggot.
12	days „ as a pupa.
8	days the supposed life of the fly.
Total . 28	

These periods, however, vary with temperature and other conditions, for maggots have been known to become pupæ as early as the fourth day of their existence, and to produce small flies : while Cleghorn believes that a large number of pupæ hybernate from November to February.

Remedies.

According to Louis the flies bred from the Rains bund emerge so long before there are any worms of the November bund, upon which to oviposit, that they die without producing offspring, and hence at this time of the year the pest almost completely disappears. Reproduction, however, is so rapid amongst the few individuals which do manage to survive that by the following Rains bund, or even by the end of the March bund, there are sufficient flies to occasion much injury. Louis recommends that a persistent effort should be made in silk factories, in the early part of each year, to destroy the pupæ of the fly. At present little is done, except by keeping the rearing-houses in almost total darkness, and closed in with thick purdahs ; and this purely defensive attitude, he considers, is insufficient to keep out the fly, while it deprives the worms of much of the light and air they require.

Mukerji notices that flies are specially injurious in the August-September bund, which is not one of the principal bunds, rearing being only done by those who have leaf left after the immediately preceding July bund. The reason why this bund is specially injured is, he believes, because the flies, which have emerged from the worms of the July bund, appear just in time to oviposit in the worms of the August-September bund. He, therefore, suggests that the practice of withholding rearing every alternate bund in the same neighbourhood, should be made compulsory through the agency of village panchaiats. This practice, being already very generally followed, the loss of the silk that is reared between the July and November bunds would not be considerable. If this action were taken, he thinks that the only remaining source of flies would be the seed cocoons, which could be obtained free of fly by rearing them under wire netting in properly managed central establishments. With regard to the advisability, however, of making regulations which must necessarily occasion at least temporary loss to those who now find, in spite of the fly, that it pays to raise an Autumn-September bund, the writer would suggest that investigations should

first be made to ascertain to what extent the reduction, which undoubtedly occurs, in the numbers of the fly at the end of the rains, is due to causes other than the scarcity of silk-worms; for it is a well-known fact that very many insects in India increase inordinately in numbers during the rains and die down again naturally with the advent of the cold weather.

The suffocation by heat to which cocoons intended to yield silk are subjected, in all cases destroys any maggots they may contain. It is obvious, therefore, that the speedy suffocation of all cocoons obtained from fly-blown worms must tend to reduce the evil; while general cleanliness in the rearing-rooms must also be useful in preventing the accumulation of dust and dirt in which the maggots conceal themselves when about to pupate.

Parasites.

Cleghorn notices that spiders destroy numbers of the flies, and that a small beetle (probably *Dermestes vulpinus*), which also attacks silk-worms and chrysalids, will eat the maggot of the fly; but that the greatest enemy of the fly is a smaller fly. He names this smaller fly "the midge," and supposes it to be parasitic upon the silk-worm fly. In proof of this he confined twelve fly-blown worms with some midges in a muslin-covered glass with earth at the bottom. The fly-blown worms had a total of twenty-one black marks upon them, each mark showing the presence of a maggot, about four days old, capable of developing into a fly. The worms were carefully tended, but produced only two silk-worm flies, together with over one hundred midges, indicating that the midges had in some way caused the death of the silk-worm flies.

The midge proves to be a dipterous insect, belonging to the family Muscidæ, and is probably a new species. Specimens, obtained by Marshall, of Berhampore, have been sent to Europe for examination; and it is hoped that practical entomologists in the silk districts, where specimens can readily be obtained, will set themselves to elucidate the interesting question of the connection which exists between this insect and the silk-worm fly. It is by no means improbable that the midge may be found to be parasitic upon the maggot of the silk-worm fly, much as the latter is parasitic upon the silk-worm; and this supposition is supported by Marshall's observation[1] of the deposition of the eggs of the midge upon the grub of the silk-worm fly, within a few hours of the latter's cutting its way out of a silk-worm cocoon.

In order to breed the midge in sufficient numbers to keep down the fly, Marshall suggests that in silk establishments a practice should be made of always putting any maggots that can be found of the silk-worm fly into a close worm basket, with a perforated lid, the perforations

[1] Indian Museum Notes, I (1), p. 63 (1889).

being sufficiently large to allow the entrance and egress of the midge while not allowing the fly to escape. He claims that this would serve two purposes; first, every maggot secured would be a fly put out of the way of doing mischief; and, second, from its being unable to shelter itself in the ground it would become a certain victim to the midge. This is no doubt an excellent suggestion for experiment, but too little is yet known of the life history of the midge to make it possible to judge whether or no the suggestion is likely to be of use. It is worth noticing, however, that if the midge were suited for extensive multiplication in the plains of Bengal, where it already exists, in all probability it would have become vastly numerous without artificial aid; for the fly upon which it is said to feed must offer, in the silk districts, an unlimited supply of food, and we know that under favourable circumstances the rate of multiplication amongst insects is excessively rapid. If, therefore, as would seem not improbable, the midge is only able to attack and thrive upon maggots which happen to be particularly exposed,—as, for example, on those collected in a basket,—it is evidently unlikely to be of much use, even if the measures suggested by Marshall have the effect of raising it in vast numbers; for the maggots which the midge is wanted to destroy are just the ones that are not caught and confined for its benefit.

Explanation of the figures.

Plate V, fig. 1, Trycolyga bombycis; a, *imago enlarged;* b, *imago nat. size;* c, ♀ *head in profile enlarged;* d, ♀ *head in profile enlarged;* e, *puparium nat. size;* f, *imago emerging from puparium, show expansions on the head;* g, *larvæ nat. size.*

II.—THE SAL GIRDER BEETLE.

Cælosterna scabrata (?), *Fabr.*

[*Pl. VI, fig. 2, nat. size.*]

In a paper published in the *Indian Forester,* November 1888, p. 503, Captain E. Wood, Conservator of Forests, Oudh, writes that during the rains coppice sal saplings suffered from an insect, which ringed the bark generally within a foot or two of the top of the shoot, the part above consequently dying and the coppice shoot becoming crooked or bifurcated.

Specimens of the insect were forwarded through the Director of the Forest School, Dehra Dun. They prove to be Longicorn beetles belonging to the species *Cælosterna cabrata,* (?) Fabr. The habits of this species are, no doubt, very similar to those of the allied American *Hickory Twig Girder* (*Oncideres cingulatus,* Say.), described by Packard in *Bull. No. 7 of the United States Entomology Commission,* p. 71 (1881).

In the case of the Hickory twig girder, the mother beetle deposits her eggs in notches, which she cuts in the bark of hickory branches. She then proceeds to gnaw a groove around the branch just below where the eggs are deposited, so that the terminal portion of the branch dies, and the larvæ, on emerging from the eggs, feed upon the dead wood.

It is well known that all cerambycid beetles prefer to lay their eggs in trees which are in an unhealthy condition, and also that trees killed by the artificial girdling of their stems are peculiarly subject to attack, the most probable explanation being that the copious flow of sap in a healthy tree is prejudicial to the life of the boring grub. We see, therefore, that the girder beetle only reproduces designedly the conditions which, when they occur accidentally, are peculiarly favourable to the development of its larvæ.

As the eggs are deposited beyond the groove, the most effectual preventive measure is obviously to collect and burn all the withered portions, so as to destroy the grubs they contain. This should be done with as little delay as possible, so that the grubs may not become fully developed and escape, in the form of beetles, before the burning takes place. In the case of the American species it has been found that the groove generally weakens the branch to such an extent as to cause it to break off and fall to the ground with the first wind; hence the systematic burning of all wind-fallen branches is sufficient to check the evil. In view of this, it would seem desirable to ascertain whether the groove made by the Indian species has the same effect, as this feature would considerably facilitate the prevention of similar damage in future years.

III.—NEO-CERAMBYX HOLOSERICEUS.

[*Plate V, fig. 3*; a, *imago* ♀ *nat. size*; b, *imago* ♂ *head and thorax, nat. size.*]

This insect has already been noticed (see No. 1 of these *Notes*, p. 60) as injuring both sâl wood (*Shorea robusta*) and saj wood (*Terminalia tomentosa*). In the case of a block of sâl wood received from the Director of the Forest School, Dehra Dun, the larvæ appear to have lived, in the first instance, upon the sap wood, and afterwards bored into the very heart of the block, which is riddled with burrows in spite of its great hardness.

This is no doubt the insect which Mr. R. Thompson describes under the name of *Cerambyx vatica* in his report on *Insects destructive to Woods and Forests* (1867).

The following is an extract from his report:—

"The *sâl*, or *Vatica robusta*, is attacked by beetles, *Cerambyx vatica* . . . . In its healthy and vigorous state the stem of the *sâl* is apparently never attacked by any description of insect, but no sooner has the flow of healthy sap ceased than a host of young larvæ are hatched. . . . This Cerambyx never attacks the timber when the bark has been removed, and it is only after the tree has been killed and the bark allowed to remain that it is resorted to by the beetles for the purpose of breeding. The experiences and observations of seven years I can offer as satisfactory evidence for the truth of these assertions.

"One is sometimes, however, struck on seeing an apparently healthy tree bearing the appearance of harbouring these insects from the excremented powdery sawdust-looking particles, which is the sure indication of their presence within the timber. On

closer examination it will be observed that the abode of the larvæ is confined to a certain space on or around the trunk, and further investigation will invariably prove that portion to be either diseased or injured in some way or other; so that a diversion of the sap had occurred, partial decay had set in, and thus prepared the apparently healthy trunk for the reception of the insects.

"During the whole of my experiences, extending, as they do, to all the forests of Kumaon and Gurhwal, from the Sarda to the Ganges, I have never, during the whole course, found any other description of beetle, except the little Buprestis previously reported, attacking sâl wood. The larvæ of both the Cerambycidæ and Buprestidæ can easily be destroyed, when within the timber, by either pouring scalding water into their holes, or by immersing the logs in a tank or in a stream of water for a couple of days. In either case the soft-bodied grubs, which the pricking of a pin is able to kill, will surely be destroyed.

"Extremes of temperature are also unfavourable to their perfect development. Hot dry winds or a too great humidity are conditions which affect them considerably. Frequently I have left a colony in a log of felled timber, hoping on my next return to find my little friends well and hearty; but, alas! for well-developed pupæ I have found nothing but dry skins, the little animals having evidently all perished from the dry hot winds then prevailing. In other instances, instead of healthy grubs, I have found them dead and mouldering from too great humidity.

"From a series of observations I have been able to arrive at the following conclusions as to the conditions necessary for their development,—*1st*, a peculiar first condition of the timber is necessary, *viz.*, partial decay, decomposition commencing in the immature portions of wood; *2nd*, bark remaining, as essential to the reception of the eggs, and consequent protection and nourishment of the young larvæ; *3rd*, their ultimate growth and maturity dependent on the state of the wood being of moderate freshness.

"If, by undue exposure or other cause, the affected timber becomes too dry, the grubs, if very young, die, as they are unable to subsist upon material which they cannot triturate; if grown to a considerable size, say from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, they will at once avoid this state by boring directly towards the centre of the log in search of a more moist residence. Here, having to subsist upon less nourishing matter than is found immediately beneath the bark, their consequent development is meagre, and the produced insects are barely one half the size of those reared under more favourable circumstances.

"In their larval state these insects are open to the attacks of both the Ichneumons and Acari, both parasitical insects, the larvæ of which feed upon the young grubs.

"From these conclusions it will be evident that, although we cannot well avoid the first condition necessary to the development of such timber-destroying insects, yet it remains with us in a great measure to treat our felled timber so that the second necessary state cannot exist,—*viz.*, by removal of the bark from the wood before it can have been operated on by the parent insect."

Neocerambyx holosericeus has been recorded as having been found in the Philippine Islands, China, and India; while in the collections of the Indian Museum are specimens from Calcutta, Murshidabad, Assam, Naga Hills, Bangalore, Ellore, Kullu, Rangoon, Perak, Johore, Andaman Islands, Nicobar Islands, and Sinkip Island. Its geograpical range is therefore considerable. Specimens were sent to Europe, where they were examined by Dr. Lameere, who determined them as *Neocerambyx holosericeus* of Fabricius. Gemminger and Harold in their *Catalogus Coleopterorum* place this species in the genus *Pachydissus* and give the

following references to the works of naturalists who have previously described it: Fabricius, Mant. Ins. I, p. 135; Olivier, Ent. IV, No. 67, p. 14, t. 17, fig. 127. In the latter work it is described as follows:—

"*Cerambyx holosericeus*, caput griseum antennis corpore paulo longioribus. Thorax inermis rugosissimus, obscurus. Elytra unispinosa, holosericea fusco-cinereoque micantia, nitida. Corpus subtus micans."

The specimens vary a good deal in size, those in the Indian Museum ranging from seven eighths of an inch to one and a half inch in length of body. The relative sizes of the antennæ in the two sexes is shown in the figure. The insect is chiefly remarkable for the golden brown pubescence with which its entire body is covered; this giving it a golden sheen, first in one part of its body and then in another, as it is turned round in a strong light.

IV.—PLOCEDERUS PEDESTRIS.

[*Plate V, Fig. 4*; a, *imago* ♀ *nat. size*; b, *imago* ♂ *head and thorax, nat. size*; c, *calcareous pupa cell, nat. size.*]

This insect has already been noticed (see No. 1 of these *Notes*, page 60) as found in Dehra Dun in sâl (*Shorea robusta*) and in Jingham (*Odina wodier*). The larva forms a calcareous egg-like case (fig. 4 c.), in which the pupa is formed. It is, no doubt, the insect described by Mr. R. Thompson in his *Report on Insects injurious to Woods and Forests* (1867), from page 415 of which the following extract is taken:—

"A third *Monochamus* beetle was found under circumstances of extraordinary development. The pupæ were discovered in solid cocoons, made of a substance resembling lime. The shell was fully the sixteenth of an inch in thickness, quite hard and firm, offering in fact more resistance to the pressure of the fingers than would a pigeon's egg. They were discovered underneath the bark, imbedded between it and the wood, in a felled tree of the *Butea frondosa*, or Dhak. The larvæ had apparently only lived on the sapwood, and underwent the second metamorphosis on the site of their original operations; another remarkable fact was that these beetles are in the perfect state as early as March."

In a foot-note Mr. Thompson adds—

"I have since obtained numerous specimens of these beetles and their cocoons, imbedded to the depth of eight inches in logs of *Odina wodier* and *Bombax heptaphyllum*. They are the commonest and earliest variety of the *Monochami* out, the perfect insects having been obtained as early in the season as November."

The species was originally described by White in the British Meseum Catalogue of Coleoptera, Part VII, page 127 (1853), under the name of *Hammaticherus pedestris*. The type specimen was from North India, and measured but one inch in length of body. The Indian Museum contains specimens from Calcutta, Maldah, Jalpaiguri, Sikkim, Sibsagar, Naga Hills, Dehra Dun, Ceylon, and the Andaman Islands; the length of body ranging from a little over an inch in the smallest specimens to

nearly two inches in the largest ones. In the plate, fig. 4 c. shows the calcareous pupa case, fig. 4 a. the female beetle, and fig. 4 b. the head and antennæ of the male to indicate the relative size of these organs in the two sexes. The figures are all natural size, and are given, though no definite information has yet been received of the extent of the injury that the insect does by boring into timber, the fact being that it is representative of a group of insects of which very little has yet been recorded in India, though they are probably amongst the most destructive with which the Forester has to deal. The chief object of the present note is therefore to direct attention to the matter in the hope of eliciting practical accounts of more complete observations on the subject.

V.—AULACOPHORA ABDOMINALIS, *Gemminger & Harold.*

(*Aulacophora foveicollis*, Baly.)

[*Pl. VI, figs. 5 a. & 5 b.*]

This insect has been sent to the Indian Museum as destructive to various crops in different parts of India. In Saharunpur it was found to be destructive to all *Cucurbitaceæ ;* London purple insecticide was tried upon it, but this appeared only to have the effect of making the beetle fly off the plant (see p. 112). Elsewhere in the North-Western Provinces it attacks water caltrop (*Trapa bispinosa*) (see No. 1 of these notes, p. 68). In Nuddea it was reported as injurious to "plants and vegetables" (*l. c.*). In Ganjam it was destructive to cotton, red gram, and cucumber (*l. c.*, p. 64). There would seem, therefore, sufficient evidence to show that the insect is a destructive one.

It occurs on both sides of the Mediterranean Sea, as well as in India, but its habits do not appear to have yet been studied.

The following is a translation, from the French, of Lucas' description, published in L'Explor. Sci. de l'Algérie, Vol. II, p. 542 (1849) :—

"Length 6½ millimetres, breadth 3½ millimetres. Head entirely smooth, vertex brilliant reddish yellow, clypeus yellow and somewhat convex, with testaceous yellow hairs sprinkled over it. Antennæ reddish yellow. Prothorax, which is somewhat broad, is uniformly brilliant reddish yellow, sparingly sprinkled with somewhat well-marked rounded punctations ; in the centre of the prothorax is a strongly marked transverse furrow, with rounded posterior outline : the edges of the prothorax are turned up, the front outline is somewhat concave, while the lateral angles both in front and behind are pronounced and but little rounded. The scutellum is quite smooth and of a brilliant reddish yellow. The elytra are altogether yellow, slightly contracted a short way from the thorax, and large and rounded posteriorily ; the humeral angles are pronounced and rounded ; the punctation is fine and close. The whole undersurface is finely punctured, and entirely black, with the exception of the prosternum and the posterior portion of the terminal abdominal segment, which are yellow. The legs are reddish yellow all over."

The name *abdominalis* is adopted by Gemminger and Harold, in their *Catalogus Coleopterorum, foveicollis, testacea,* &c., being given as synonyms; the following is their synonymy :—

Aulacophora abdominalis, Fabr. Spec. Ins. I, p. 151.—Hübn. Naturf. XXIV, p. 43, t. 2, fig. 9.—Oliv. Ent. VI, p. 623, t. 2, f. 22.—Gerstäck, Peters. Reis. Zool., 1862, p. 342.—India Or.
flavicans, Dej. Cat., 3. ed., p. 402. Java.
♂ *foveicollis,* Küst. Käf. Eur. 28, 100.—Luc. Expl. Alg. Ent., p. 542, t. 44, f. 9.—Fairm., Gen. Col. Eur., IV, t. 69, fig. 327. Dej. Cat. l. c.—Africa.
♂ *crioceroides,* Dufour *in Litt.*,—Europe Mer.
♀ *nigriventris,* Redtenb. Denkschr. Ac. Wien., I, p. 50 (1850). Persia.
testacea, Fabr. Mant., I, p. 87, (1787). India Or.
indica, Geml., Ed. Linn., 1, 4, p. 1720. India Or.
melanogaster, Latreille *in litt.* India Or.

It must be noted, however, that Baly, in his paper published in the Journal of the Linnean Society of London, Vol. XX, 1886, gives three distinct species, *viz.*—

(*a*) AULACOPHORA TESTACEA, Fabr., Mant. Ins. i, p. 87. (1787).
Habitat, India (*Fabr.*); Assam (*Chennel—Collection Baly*).

(*b*) AULACOPHORA ABDOMINALIS, Fabr., Spec. Ins. i, p. 151.
Habitat, Islands of the Pacific Ocean (*Fabr.*): Western Australia (*Collection Baly*).

(*c*) AULACOPHORA FOVEICOLLIS, Küster. Käf. Eur. xxviii, p. 100.
Habitat, Southern Europe, Northern Africa, India.

According to Baly's description the insect in question belongs to the species *foveicollis,* but it seems only necessary to indicate the fact, as the sole object of this note is to direct attention to the pest with a view of collecting reliable information as to its life history, the injury it occasions, and the most promising methods of dealing with it.

VI.—PAPILIO ERITHONIUS.

[*Pl. VI, Fig. 1;* a, *imago;* b, *pupæ;* c, *larva; all nat. size.*]

Caterpillars of the butterfly *Papilio erithonius,* Cramer, were sent to the Indian Museum in the early part of 1888 by Mr. J. Cameron of Bangalore, with the information that they attacked lemon trees. Excellent models of the same caterpillars have this year (1889) been received from the Botanical Gardens, Saharanpur. In sending them Mr. Gollan notices that the insect does much damage to young budded oranges, not a plant of which could be raised if boys were not kept to pick off the caterpillars. Mr. Gollan subsequently experimented with London purple insecticide upon the caterpillars and his remarks on the subject (for which see also page 112) are here quoted to facilitate reference :—

"The last experiment tried was upon the caterpillar I previously wrote to you about and which has proved so destructive to our young budded oranges. I do not

know its name, but it is the larva of a butterfly, as you surmised; and as I am sending you the insect in all its stages, I have no doubt you will be able to name it. The London purple in this case was also a complete success. Owing to previous hand-picking there were only a few caterpillars on the trees when sprayed upon, but the few noticeable were destroyed with one application, and none have since appeared."

The figures are taken from specimens reared by Mr. Gollan.

De Niceville writes[1] as follows of *Papilio erithronius* :—

"I have had considerable experience in breeding this species, the larva of which I have most frequently found on the Bael (*Ægle marmelos*), but it feeds also in Calcutta on the orange, pomelo, lime, ber (*Zizyphus jujuba*), and a low-growing weed, to be found in all waste places, called *Glycosmis pentaphylla*. The eggs of *P. erithronius* are always, as far as I know, laid on the very young shoots and leaves on which the young larvæ exclusively feed. When they grow older the caterpillars eat the old and full-grown leaves. I have often watched Papilios in the act of ovipositing, and have never known a female to lay more than two or three eggs on any one plant or bush. They are very careful as to the position where the eggs are laid, and often take some moments to decide whether an egg shall be placed or not on a particular leaf or young shoot. The eggs are conspicuous objects, being pale yellow in colour and perfectly smooth. The young larvæ closely resemble the droppings of birds, and always rest fully exposed to view on the upper side of the leaves. They are probably protected, not only by their superficial resemblance to something uneatable, but in addition are furnished with a strong, but to me not at all disagreeable odour, which, however, may be very repugnant to the taste of birds. I rather doubt the tentacles with which the larvæ are furnished being scent-organs. I fancy they are entirely used to frighten away their enemies. The extreme rapidity with which they can be thrust forth, their large size and bright colour, would not unlikely drive off a female Ichneumon-fly in the act of depositing her eggs in the body of the caterpillar, and this fly is certainly the greatest enemy the butterfly has. When full grown, the larva dons quite a different livery, being green, with some oblique markings on the sides. At this stage it usually rests on the stems of the leaves, where it is well hidden."

Papilio erithronius is related to the "Orange dog" *Papilio cresphonte*, which often completely defoliates young orange trees in Florida. The life history of the "Orange dog" was investigated for the United States Government by Hubbard, who writes[2] as follows :—

"The eggs are spherical, smooth, and pearly in lustre, with a dull-red or reddish-yellow tinge, and are deposited singly, invariably upon the youngest and most tender shoots, usually upon the tips of the budding leaves. The butterflies appear with the opening of spring from chrysalids formed in November and December; the first eggs are deposited early in February or as soon as the new growth appears upon the orange trees. The eggs hatch in ten or twelve days; the caterpillar completes its growth in about thirty days, and remains in the pupa case attached to the trunk or large branch from ten to fifteen days. About two months is thus occupied by a single brood, and there are four full broods during the season, beginning with February and ending with October. The breeding is, however, continuous during the summer, and eggs are laid whenever new growth appears upon the orange trees. The ovaries contain over 500 eggs, the laying of which occupies the female many days; she scatters them over a wide area, seldom depositing more than four or five upon a single plant. The young caterpillars feed at first only upon the tenderest leaves, but, when well grown, demolish both

[1] *Asian*, 7th February 1888.

[2] See his "Insects affecting the Orange," Washington, 1885.

leaves and shoots, which have not hardened into wood. On account of its large size and voracity the Orange Dog does great damage, particularly to young trees, which are sometimes completely defoliated. Hand-picking is not a very difficult task in the case of so large an insect, and must in most cases be relied upon to keep young trees free from Orange Dogs. As the eggs are quite large and conspicuously placed at the tips of the growing stalks and budding leaves, it is a simple matter to find and pinch them between the fingers. A very little practice will enable the orange-grower to go rapidly through his young grove and destroy by hand nearly every egg. If this method is systematically pursued, the result will well repay the trouble. Two rules should be borne in mind, and will greatly facilitate the work. First, only those trees which are pushing out tender sprouts need be examined for eggs and young larvæ; secondly, in nearly all cases the eggs are laid upon sprouts at the top of the young tree and not upon those low down and near the ground."

Hubbard notes, however, that

"while this rule in regard to the disposition of the egg can be predicted with great confidence for the orange district of Florida, it is but just to observe that it may not hold good for Louisiana and other more northern localities. Mr. Howard has, in fact, found the eggs upon the older leaves and on the twigs orange trees in Savannah, Georgia."

In addition to the destruction of the eggs Hubbard recommends that the butterflies themselves should be destroyed, as they flit through the orange grove.

VII.—OPIUM CUT WORM.

Agrotis suffusa (?).

Injury done by the pest.

Mr. J. Cockburn (Assistant Sub-Deputy Opium Agent, Auchin,) has furnished a report on this insect, which often does considerable injury to the young opium poppy in the North-Western Provinces. Writing on 21st February 1889, he observes—

"Here, in the Fatehgarh District, their ravages are in full swing among the smaller plants. . . . . I have this year seen scores of acres as effectively swept clean by these insects as they could have been by any swarm of locusts, and the larva must do damage to the value of many thousand pounds annually, both to Government and to the ryot."

Scott, in his Opium Reports for 1874, 1877, and 1878, describes this pest as specially destructive to young crops in dry seasons, often stripping beegha after beegha of plants in a few nights.

Life history of the pest.

The young caterpillars, which are sombre-colored and of the typical Noctues shape, appear between November and March, sometimes in vast numbers, upon the opium plants. Scott supposes that they are hatched from eggs previously laid by the moth upon the bare ground, but this has not yet been ascertained. If the plants are more than about 5 inches high when the caterpillars appear, only the lower leaves are gnawed and little damage is done. Scott supposes this is because the juices of the poppy leaves have by this time become too pungent for the insect to eat. Young plants less than 5 inches high are the ones that suffer. The *modus operandi* is as fol-

lows: The caterpillar gnaws off the plant close to the ground and drags it towards its burrow, often leaving it on the way to wither, and attacking a fresh plant. The plant, which is a delicate one, dies, and much damage is often done. Scott estimates that one caterpillar will cut down at least from fifty to one hundred plants in a single night, while Cockburn notices that four caterpillars will clear a bed that is six feet square in a week. The caterpillars are nocturnal in their habits and rest during the day in natural cracks or holes they have burrowed an inch or two deep in the ground. These holes are often marked by the protruding ends of leaves and stems they have dragged into them. In dry weather they keep close in their burrows in the day-time, while in damp cloudy weather, they may be found on the surface all over the field.

When full fed, the caterpillar, which is about ½ inch to 2 inches in length, buries itself from 2 to 8 inches deep in the soil, and there constructs a firm irregular oblong cell of earth, in which it pupates. The specimens that Scott kept in captivity, emerged after resting in the pupa state for rather less than a month.

The moth is common from the beginning of February to the middle of March; it often appears in vast numbers, and is attracted by a light. Scott thinks there are two generations in the year, one fed upon the opium poppy in the cold season, and the other upon the legumes and pulses of the rainy season.

The determination of the pest.

The determination of the pest is still somewhat doubtful. It is known in Ghazipur as *Kerouna*, in Fatehgarh as *Suree*, and in Behar as *Kumwah*. In the Indian Museum collections is a specimen of the Noctues moth *Agrotis suffusa*[1] marked "Ghazipur Opium Agency, 3rd February 1879." This cosmopolitan species is well known as a cut worm and has habits similar to those described for the opium pest. The figure given by Scott, in his report on the experimental culture of the opium poppy 1874, certainly represents a species of the genus *Agrotis*, while it may pass for *Agrotis suffusa*, though the wing markings, probably owing to imperfect lithography, differ somewhat from those of the actual specimen of *Agrotis suffusa*. The precise determination of the species can only be finally settled by entomological examination of authentic specimens of the moth, but on the whole there seems to be little doubt that the pest will prove to be *Agrotis suffusa*.

Remedies.

Crows, mynas, starlings, the cattle egret, and other birds all eat the caterpillars whenever they can get at them. They are particularly active in damp weather and after irrigation, when the caterpillars come to the surface. Irrigation is

[1] For accounts of this species see Economic Notes, I, No. 1, p. 33; also p. 103 of this number.

largely used for this purpose, but the help of the birds is usually insufficient, and hand-picking has also to be resorted to for getting rid of the exposed caterpillars. The cultivator usually goes round his poppy plot in the mornings, armed with a spud, with which he digs out the caterpillars from the bottom of the holes, where he sees leaves and stalks protruding. Scott found that the pest could easily be checked by dusting the plants over a few times in the evenings with a mixture of quicklime and ashes, but the cultivators generally do not appear to resort to this method. With regard to the method recommended by Dr. Riley for cut worms in America,—that is to say, the poisoning of the worms by strewing leaves poisoned with London purple or Paris green over the field, before the crop appears above the ground,—Mr. Cockburn writes :—

"I think the plan . . . would be readily taken to by the cultivators, as the system of poisoning jackals and porcupines is well understood."

VIII.—HELIOTHIS ARMIGERA.

[*Plate VI, fig. 4*; a, *imago*; b, *pupa*; c, *larvæ*; *all nat. size.*]

The pest in India.

The following account of the opium pest *Heliothis armigera* is taken chiefly from Mr. John Scott's opium reports, published in 1874, 1876, 1877 and 1878, respectively.[1] Scott describes the insect under the name of *Mamestra papaverorum*; specimens, however, were submitted at the time by Dr. Anderson to Mr. F. Moore, who determined them as belonging to the already well-known species *Heliothis armigera*, and the figures published by the United States Entomological Commission leave no room to doubt the accuracy of Mr. Moore's determination.

When the opium poppy plants are approaching maturity small caterpillars are often found feeding upon the cuticle, and occasionally also upon the margins, of the lower leaves. These caterpillars remain chiefly on the under surface of the leaves—a habit which, with their leaf-like color, affords them considerable security from insectivorous birds. As they grow bigger the caterpillars mount to the upper leaves, and, like the maturing plant, gradually assume a yellowish-brown tinge, finally becoming ash-grey in general color, marked with one dorsal and two lateral

[1] In 1878 a series of specimens of insects injurious to opium cultivation were sent to the Indian Museum by Mr. John Scott, who was then in charge of the Deegah experimental gardens, Behar. In his annual reports Scott gave practical accounts of these in sects, but the only one of them that could at the time be determined entomologically was *Heliothis armigera*. The orignal specimens are still in the Museum, but most of them are in too poor a state of preservation to make anything of; an account, however, of the *Opium Cut Worm* that he describes is given on p. 95, and it is hoped, as fresh specimens are obtained and further observations made, that all the insects that attack opium may be figured and described, so that Scott's practical investigations may be made easily available for reference, and confusion avoided by ascertaining the designations under which the insects he notices are known to entomologists.

longitudinal stripes of pale reddish-brown. At this stage they bore into the seed capsules, which to suit them must be either somewhat advanced, with much of the drug extracted, or else naturally deficient in narcotic juice; for they carefully avoid the young healthy capsules, the milky juice of which, as Scott found by experiment, has a strong narcotic effect upon them. One caterpillar will eat, or at least render useless, the whole seed contents of an ordinary capsule. The fate of the insect, however, according to Scott, greatly depends upon the amount of seed in the capsule it has attacked; for, if the capsule happens to be a small one, the caterpillar leaves it, after clearing out the contents, and then strays over the plant, nibbling other capsules, and sometimes even boring into the stalk, until finally it withdraws to the lower part of the plant, where it pupates in a small cocoon attached to the underside of a leaf, and with a portion of the margin of a leaf folded over it.[1] If, on the other hand, there is more seed in the capsule than it can get through, it generally pupates within the capsule, the result being that from 70 to 90 per cent. of the insects perish; for the moth, on emerging from the chrysalis inside the capsule, is generally unable to escape through the small hole that was cut by the larva in the tough wall, and there is no other means of egress. In proof of this observation Scott collected some four hundred pupæ and moths, all of which he found entrapped in the capsules of poppy plants growing on a plot of ground but five cottahs in extent. From the extraordinary mortality which he observed at this stage of the insect's life Scott concludes that the opium poppy has only comparatively recently become the food-plant of the insect, which he supposes has not yet completely accommodated itself to it.[2] He notices incidentally that mynas very often perch upon the infested capsules and snap up the caterpillar as soon as it appears at the opening, where the bird can get at it; this may in some cases account for caterpillars not leaving the capsules before pupating: the matter, however, would seem to require further elucidation, especially as in America the caterpillars of this species always pupate in the ground.

When full fed the caterpillar (fig. 4 c.) is from an inch to an inch and a half long, and about the thickness of a goose-quill; it is of the usual Noctues shape, with the full complement of five pairs of short fleshy abdominal prolegs, besides the three pairs of thoracic legs. The pupa (fig. 4 b.) is chestnut brown in color and of the usual Noctues shape. The moth (fig. 4 a.) is dirty-brown in color, marked as shown in the plate, and varying much in tint.

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[1] In America the species pupates in the ground; this observation therefore requires confirmation.

[2] The writer is inclined to think that more of the moths may escape from the capsules than Scott supposes; for when freshly emerged from the pupa case and before the wings have expanded, many moths make their way through narrow and even through much obstructed passages. It is sufficient to instance the silk moth, which, after emerging from the pupa case, works its way through the tough and closely-woven tissue of the silk cocoon.

From the fact that young caterpillars first appear upon the lower leaves, Scott thinks that the eggs are probably deposited upon the ground. In America, however, the eggs have been found deposited all over the cotton plant; the probabilities are, therefore, that this will also be found to be the case upon the opium poppy in India.

Besides the opium poppy, which it attacks in Upper Bengal, the North-Western Provinces, and the Punjab, *Heliothis armigera* feeds upon various pulses, both those that grow in the cold weather and also those that grow in the rainy season. The caterpillar feeds upon the seeds and seed-pods of the pulse, but never gets entrapped in them, as in the opium capsule. From his observations Scott concludes that there must be at least two generations in the year, while from the life history of the insect in America there would seem to be every reason to expect that there are considerably more than this number in India. Attacking, as it does, chiefly the lower surface of the leaves and the interior of the capsules, Scott thinks that hand-picking is the only mode of keeping the insect in check. In this opinion he is supported by Mr. F. Moore, the well-known entomologist, to whom in 1878 specimens of the insect were submitted by Dr. Anderson for examination.

Dr. Anderson's notes.

In his report, dated 3rd July 1878, to the Board of Revenue, on *Heliothis armigera*, Dr. Anderson writes—

"I consider that the facts which have been adduced by Mr. Scott regarding the habits of the caterpillars of this moth are strong evidence in support of his opinion that the opium poppy is not the natural food of the larvæ of *Heliothis armigera*, and Mr. Moore's statement that this is the first time he has heard of the insect's attacking the opium poppy is confirmatory of Mr. Scott's opinion. Mr. Scott remarks, 'I can speak from careful, and now indeed extensive, observation that neither this caterpillar nor any other which I have made experiments with, will attack the parts of the opium poppy when in any way replete with a normally concentrated milk sap.' He limits the attacks of caterpillars to two critical stages in the life of the plant: first, the germination of the seed and early growth of the young plant; and, secondly, the mature stage, when the juices are exhausted. The larvæ, however, of certain species of moths have a perfect immunity from the poisonous principles of some of the most deadly plants. The caterpillar of *Deiopeia pulchella* feeds on the kernel of the seed of *Physostigma venenosum*, which contains the virulent poisonous principle *eserine*, and the pupæ have been found in the centre of this hard bean apparently entrapped, much in the same way that the pupæ of *H. armigera* are in the capsules of the poppy. The insect is widely distributed, even perhaps more so than *H. armigera*, occurring, like it, in India; so that *Physostigma venenosum* is not the exclusive food of its larvæ any more than the opium poppy is the exclusive food of the larva of *H. armigera*.

"It has been proved by experiment that the excrement of the larva of *D. pulchella* contains the poisonous principle of the bean unaltered, and to that strength that when half a grain of the excrement had been administered to a linnet the bird died in several minutes."

Dr. Anderson observes that though apparently insensible to the active principle of the Calabar bean the caterpillar is easily poisoned by hydrocyanic acid, and he goes on to notice—

"That the juices of the opium poppy in protecting the plant against the attacks of insects renders the opium poppy very different in this respect from other poisonous plants, the poisonous principles of which, however deadly, do not confer on the plant immunity from the attacks of some insects. Moreover, certain poisonous plants are eaten without any ill effects by certain insects, which also derive a share of their food from other and non-poisonous plants."

The pest in other parts of the world.

Besides occurring in India, *Heliothis armigera* is found in Ceylon, Java, Australia, New Zealand, Europe, North and South America, and the West Indies;—it is, in fact, cosmopolitan. In 1885 Dr. Riley published an account of the insect, in the 4th report of the United States Entomological Commission, and the following is an abstract of his paper.

The Noctues moth *Heliothis armigera*, which is commonly known in America as the *Boll Worm*, may be considered to be one of the foremost of injurious insects in America. In many parts of the Southern States it is the chief cotton pest, while, taking one year with another, there can be little doubt but that maize suffers more from it than from any other one pest, not excepting the *Clinch Bug*. With tomatoes, peas, and beans, though the injury is not great generally, yet occasionally much damage is done locally. There are at least three generations in the year that attack maize; the later generations attacking cotton. It is to the pest as found attacking the cotton plant that Dr. Riley's paper chiefly refers. The habits of the insect, however, are pretty certain to be identical, at least throughout North America, upon whatever food-plant it may be found.

A single female is able to lay as many as five hundred eggs, which are nearly white in color, and may easily be seen against the green background, deposited all over a cotton plant. The favorite time for oviposition is at dusk, when the moths may be seen flying in great numbers about the cotton-fields. The eggs generally hatch in about four days after they are laid. The time, however, varies with the temperature, warmth accelerating and cold retarding development. At first the young larva feeds on a leaf close to where it emerged from the egg, but it soon begins to crawl about the plant, often lowering itself by a silken thread, and feeding upon the leaves all over the plant. Occasionally it completes its growth and becomes full fed upon the leaves alone. Usually, however, long before it is full fed it bores into some bud or boll. Dr. Riley writes—

"As the worms grow they attach larger bolls, the young larvæ having mainly confined themselves to the buds and newly-formed boll. The worms may therefore be said to progress downwards, the younger individuals being found mainly upon the top crop, while the older larvæ bore into the older bolls of the middle crop, the bottom crop being seldom seriously damaged by Heliothis. The half-grown worm, finding a boll of suitable age, begins at once to gnaw through the smooth covering, soon forming an opening as large as the diameter of its body, and through this opening it gradually works its way into the interior of the boll. Frequently the spot first tried proves too hard or otherwise distasteful, and the worm leaves it either for another boll or for another spot on the same boll. Infested bolls can usually be distinguished by the

opening, but occasionally this is hidden by the involucre. Having devoured, or partially devoured, the contents of one boll, the worm leaves it for another. Even if, however, the damage to the contents has been slight, rain penetrates through the opening, the boll soon rots and attracts other insects (principally Dipterons and Coleopterons), which finish the work of destruction. In this way an immense amount of damage can be done by a single larva.

"As the worms increase in size a great diversity in coloration, and also in markings, appears. Those individuals which have nearly reached their full growth vary from a dark brown or rose color to a light green, the latter being, perhaps, the predominant shade. Almost every conceivable intermediate stage of color is to be seen, while the markings vary almost as greatly. It seems to be well settled that the green worms are most abundant in the spring, while later, as the cotton blossoms out fully.....the pinkish variety becomes more abundant, and the brown worms do not appear in force until fall.

"In markings the worms vary from almost perfectly immaculate, unstriped individuals, to those furnished with many spots and regular stripes. The commonest (we can hardly say the normal) arrangement of the markings is as follows. On each side of the body, extending from the head to the anal joint and including the spiracles, is a broad, whitish, lateral or stigmatal stripe. Just above this is a lesser subdorsal dusky stripe. Down the middle of the back is a narrower, dusky, mediodorsal stripe, including a fine white line, and between this and the subdorsal dusky stripe, in what may be called the dorsal space, are four or five very delicate whitish lines, so delicate in fact as not to interfere with the general color of the body. Of spots there are usually eight dorsally to each abdominal joint, normally black in color, the four dorsal spots arranged trapezoidally, the anterior pair closed together. These spots are simply piliferous tubercles, and are very constant, a close examination of even the immaculate individuals showing them still to be present, though colorless. Upon the meso-and meta-thoracic joints these tubercles are arranged across the dorsum in a single transverse row. Of the stripes the most constant appears to be the whitish lateral, all the others being more often wanting. That these color varieties are not caused by a difference in food is shown by the fact that all the variations occur in specimens feeding on one and the same plant. Those feeding on maturing corn are always dark, however, and the colors brighten in proportion as the larvæ are exposed and not hidden in feeding..... The full-grown, well-developed worm averages 4 cm. (1·57 inches) in length and about 7 mm. (0·27 inch) in diameter. On arriving at full growth the worm works its way to the ground, and choosing a spot where the earth is somewhat compact, rather than loose and friable, burrows beneath the surface and forms a subcylindrical, straight or sloping gallery to the depth of from 3 to 6 inches. This gallery is slightly closed at its mouth and gradually widens towards its lower end, where the worm transforms to a pupa.....Deprived of all earth, we have known the Boll Worm to pupate nakedly, and in apparently as healthy conditition as though the surroundings had been normal.....*Heliothis armigera* is an extremely variable species, as would naturally be expected from its multitudinous food-plants and its almost unlimited distribution. In general color the moths vary from a dull ochre-yellow to a dull olive-green.....Many individuals exhibit almost immaculate front wings, while in others the typical markings are deepened. .....In a general experience covering some twenty years with this moth, as found in corn-fields in the West, and covering some half-dozen years in the cotton-fields of the South, we believe that the former are on an average brighter-colored and darker than the latter. The markings of the hind wings, although much more constant than those of the fore wings, vary principally in the breadth and depth of color of the dusky band on the hinder margin, and in the size of the light spots within this band. .....It is impossible to speak with any degree of definiteness concerning the number of annual broods of the Boll Worm in the Southern cotton-fields. A confusion of

generations begins very early in the season, and we soon find the worms in the field in all stages. Accidental circumstances may favor the development of the descendants of one moth and retard that of another. Generation after generation is produced until the approach of cold weather, and consequently much depends on the length of the season. The average length of time occupied by the insect in all of its transformations is, say, 38 days, and this, allowing from the 15th of April to the middle of October as the active period of its life, would give us five broods. This is, so far as we can ascertain from actual observation, the normal number throughout the more southern portions of the cotton belt."

The insect usually hybernates in the pupa state, and it is possible also that a few of the moths which happen to issue late in the autumn may survive the winter.

In the case of maize the eggs are deposited in the early spring upon the leaves, and the larvæ of the first generation feed upon the tender leaves and buds ; it is the second and third generations of larvæ, however, appearing, as they do, when the grain is more advanced, that occasion most of the injury. In affected maize cobs the husks are pierced by circular holes, and upon opening them the grain is found to be eaten in furrows, principally at the end of the cob. The worm does not confine itself to a single cob, but often moves in the night time and attacks a fresh one, into which it enters by a circular hole, which it bores through the husk, as in the cob it has left. Several worms in different stages of development are often found in a single cob. When full fed, the worms bore their way out, and crawl down to the ground, in which they pupate.

When the caterpillars attack tomatoes they bore into both ripe and unripe fruit, thereby causing it to rot. When they attack Leguminosæ they bore into the seed-pods. They have also been found eating the flowers of melons, and boring into the stems of geraniums, besides feeding upon the leaves of geraniums, tobacco, and many other plants. In addition to feeding upon plants, the caterpillars of the *Boll Worm* have been known occasionally to devour the pupæ of the *Cotton Worm* (*Aletia xylina*), while the larger individuals often prey upon the smaller members of their own species. The species, therefore, may be looked upon as practically omnivorous. Amongst the natural enemies of *Heliothis armigera* may be noticed bats and poultry, which destroy large numbers of the pest; some Tachinid, Ichneumon, and Chalcid flies have been recorded as parasitic upon the worm, and some wild birds also assist. None of these, however, appear to have much effect in keeping down the numbers of the pest.

Amongst remedies, topping the cotton plants is noticed as having been much advocated, though Dr. Riley himself is of opinion that this measure is not of much use. Fall ploughing, to destroy the hibernating pupæ, by exposing them to the cold of winter, is recommended in countries where there is frost; this remedy is of course inapplicable in

India. Some good results have been obtained by catching the moths in lantern traps, and also by basins containing a mixture of molasses and vinegar, to destroy the moths, which are attracted by the smell of the mixture and get drowned in trying to feed upon it. Dr. Riley also thinks that much may be done by hand-picking the earlier broods of larvæ. Arsenical poisons, such as London purple and Paris green, do not reach the worms that are inside the cotton bolls, but may advantageously be used for destroying those feeding in the open. Spraying the plants with *pyrethrum*, Dr. Riley thinks, is a promising remedy, for the *pyrethrum* appears to destroy both the worms feeding in the open and those inside the bolls. There is no record, however, of the adoption of this remedy on any but an experimental scale.

IX.—CECIDOMYIA ORYZÆ, *Wood-Mason.*

[*Plate VI, fig. 6*; a, *imago, wing enlarged*; b, *pupa, dorsal view enlarged*; c, *pupa, ventral view enlarged.*]

The following is an abstract of the correspondence published in the Supplement to the *Calcutta Gazette* of 8th December 1880:—

In october 1880 the Magistrate of Monghyr reported serious injury to the dhan in the Kurruckpore thana, by some insect that had not before been known. Specimens were forwarded to the Indian Museum and were examined by Mr. J. Wood-Mason, who reported that they consisted of pupæ, pupal skins, and an adult female belonging to the Dipterous genus *Cecidomyia*, and to a species which he provisionally named *Cecidomyia oryzæ*. Nothing seems to have been previously known of this pest, which is one of special interest as belonging to the same genus as the destructive "Hessian fly" (*Cecidomyia destructor*) of Europe and America. Mr. Wood-Mason observed that the insect was viviparous, and he thought it likely that the young maggots were deposited by the mother fly upon the developing panicle, or "ear," of the rice plant. The figures of the insect were prepared in the Museum under Mr. Wood-Mason's supervision at the time of his report, and are now published with a view of directing attention to the existence in India of a pest which, on *à priori* grounds, is likely to be an important one, though nothing seems to have been heard of it since 1880.

X.—MISCELLANEOUS PESTS.

Agrotis suffusa.

A caterpillar of the moth *Agrotis suffusa* was received on 17th May 1889 from the Department of Land Records and Agriculture, Bengal, with the information that it had been doing considerable injury to the potato crop in the neighbourhood of Kurseong. The officer in charge of the experimental potato plots at Kurseong reported that the insect appears chiefly in years when the rainfall is deficient. It cuts the potato plants at night and shelters itself

underground in the day-time. The caterpillar that was received transformed into a pup aon 17th May and emerged as a moth on 28th of the same month. Some of the London purple, sent to the Indian Museum for experiment by Messrs. Heminway & Co., of 60, Mark Lane, London, has been forwarded to Kurseong for experiment with this pest.

Achæa melicerte.

Specimens of a caterpillar known locally as *Janga purugu* were received on 29th January 1889 from the Superintendent of the Government Central Museum, Madras, with the information that the insect caused a considerable amount of damage to castor-oil plants in the Madras Presidency.

The caterpillars were found to be larvæ of the Noctues moth *Achæa melicerte* of Drury (Catalogue of the Moths of India by Cotes and Swinhoe, p. 402, No. 2624). This moth is common in all parts of India, besides occurring in Ceylon, Celebes, and Australia. It has been found feeding on castor oil, both in Ceylon and in Calcutta, and on *Ohrar dhal* in Dehra Dun. The insect, being a leaf feeder, can probably easily be destroyed by spraying an insecticide, such as London purple, over the affected plants.

A small supply of the London purple that was sent to the Indian Museum for experiment by Messrs. Hemingway & Co., of London, and also a force pump, similarly sent for experiment by Messrs. Rumsey & Co., of New York, have been forwarded to the Superintendent of the Madras Museum, who has undertaken to have them experimented with and reported upon in connection with this pest. When the report is received it will be published in *Indian Museum Notes.*

Shooa poka.

The following is a letter, dated Ranchi, 30th August 1888, from Mr. E. W. Collins; it was forwarded to the Museum through the Department of Land Records and Agriculture, Bengal:—

"I have the honor to forward by post a few specimens of the chrysalis of a moth of which the grubs were found in large numbers in the gardens about here, feeding on all kinds of garden plants, particularly on the leaves of gourd. They were first found in the middle of July,—that is, about a fortnight after the first fall of rain late in June. I found dense masses of these caterpillars, which were then very minute and of greyish color, on the tops of full-sized gourd leaves on which they were voraciously feeding. I cannot say that the damage done by the caterpillars to the gourd plants was in any way great or even appreciable; but I believe that the damage would have been greater and made itself felt but for the heavy shower which followed and evidently dispersed or washed away the grubs. As the grubs were, however, very numerous and a source of great nuisance, some entomological interest might attach to the insect, and it is in this hope that I have thought fit to forward a few chrysalides for identification.

"On discovering the caterpillars, I took up a few of them and reared them in an earthenware pot on fresh gourd leaves, which were given them to eat every day. From being tiny, grey worms, they gradually increased in size, till they became about $1\frac{1}{4}$" long, yellow in color, with a black band behind their mouth, and covered with black

straight hair all over the body, which made them exceedingly disgusting to look at. In this form the grubs are known to us as a species of *Shooa poka, i.e.*, 'spiny worms,' which are rather dangerous to touch, as the sharp spines enter into the skin and set up irritation and thereby cause inflammation. From the time the eggs were hatched, the caterpillars took, on an average, three weeks to quiet down into chrysalides. The average period of the 'pupa' stage is much shorter than the larva stage, being about ten to twelve days. The few specimens of chrysalides sent for identification are the only ones I have now with me, and these are forwarded in the hope that they will reach Mr. Cotes before undergoing their final metamorphosis."

The specimens received are Bombyces moths belonging to the genus *Spilarctia*, and probably to the species *rubilinea* of Moore—see Catalogue of the Moths of India, Cotes and Swinhoe, No. 842. A report on a pest known as *Shooa poka* in Basirhat is given on page 69 of No. 1 of these Notes; the insect is reported as very injurious to jute, sometimes entirely destroying extensive fields of this crop.

Sorghum-borer moth.

With reference to the Sorghum-borer moth described on page 28 of *Indian Museum Notes*, I, No. 1, Mr. G. Marshall Woodrow, of Poona, wrote on 22nd January 1889, that in the Deccan one-half to three quarters of the crop on some fields is destroyed, while other fields escape injury. He estimates that about one per cent. of the total jowaree crops (*Sorghum vulgare* and *Sorghum saccharatum*) is yearly lost through the ravages of this pest.

The following is an extract from a letter, dated 3rd February 1889, from the Director, Land Records and Agriculture, Assam:—

Mustard caterpillar.

"I have forwarded to you by parcel post a small bottle, containing certain caterpillars which cause much destruction to mustard crops in this province. I saw this morning an entire field completely ruined. The caterpillar is called *Bhur* by the Assamese, who appear to know nothing about its history, and say they have never seen either the eggs or the chrysalis. They allege that it only attacks mustard, and a few vegetables; that it is more prevalent when the crop springs up in cloudy weather in Aghan (November 15th to December 15th) than when the young shoots appear in bright sunlight. The Kacharis imagine it is deposited by rain. If the crop has grown a little, it is not liable to be injured, as apparently the young caterpillars require tender leaves to feed on. It is thus not uncommon to see one field quite ruined and the one next it, sown earlier, in capital condition. The fact of the *Bhur* having done harm in one year does not prevent the people from growing mustard in the same field the following year.

"I may add that the *Bhur* is often associated with a kind of green fly, exactly like the Aphides of rose bushes. This green fly is called *Mowa* or *Mewa* by the Assamese, and often appears alone. It clusters in large numbers on the stalk, and appears to affect the flower. The *Bhur* eat the leaves, and probably the flowers too."

The specimens were found to be the larvæ of a small moth (probably one of the Pyrales), which cannot be precisely determined without specimens of the imago. It would be useful to obtain specimens of the chrysalis, and also of the larvæ, in other stages of development, together with the moth, so that representatives of all the stages of the insect may be preserved in the Indian Museum for future reference.

The Orange beetle.

In the Collections of the Indian Museum are specimens of the Phytophagous beetle, *Diapromorpha melanopus*, received in 1885 from Sibsagar, Assam, from Mr. S. E. Peal, who calls the insect the "Orange beetle," and notices that it eats the stems of tea-shoots, so that they wither and droop. The insect is a common one in India, the Museum containing a considerable number of specimens collected in Sikkim, Sibsagar, Birbhum, Murshedabad, Sahibganj, Calcutta, and Maldah. Gemminger and Harold, in their *Catalogus Coleopterorum*, give Bengal and Siam as the habitat of the species; the following is their synonymy :—

Diapromorpha melanopus—
melanopus, Lacord. Mon., p. 238.
" Dej. Cat., 3rd edit., p. 442.
pallens, Olivier, Ent. vi, No. 96 (Clytre), p. 863, pl. 2, fig. 27.

Opium pest *Gibbium scotias.*

Some specimens of the insect were forwarded to the Indian Museum in November 1877 through the Board of Revenue; they were sent to England and submitted to Mr. F. Moore, who determined them as probably belonging to the common European species *Gibbium scotias*, of the family Ptinidae, which comprises a large number of small but destructive species of beetles.

In forwarding the specimens, Dr. T. J. Durant (Principal Assistant, Behar Agency) reported that the insects were found in a well-closed opium chest, which emitted a disagreeable damp odour. The outer shells of the opium cakes were somewhat injured by the insects, which had not burrowed into the interior, but simply eaten away patches on the exterior. He noticed that this pest is nothing like the well-known insect[1] that often attacks opium cakes and works its way right through the shell, leaving a round hole.

Calandra oryzæ.

The following extract from a letter, dated 14th March 1889, from Mr. H. M. Ross, of Calcutta, shows the susceptibility of the weevil. The immunity from attack in the case of the samples kept in bags may possibly have been due to some accident, such as the spilling of a little kerosene oil from a lamp over the bags, before they were put upon the table with the wheat samples; this, like the naphthaline and bisulphide of carbon that have been experimented with, would probably have the effect of keeping away weevils for a considerable period.

"To-day I discovered half a dozen samples of rice, which have been kept in paper bags on a table for the last eight months, to be free from weevils, while so close to them as to be actually in contact were a great number of wheat samples, confined in the boxes.

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[1] Probably *Lasioderma testaceum*—see Economic Notes, I, No. 1, page 37.

These boxes were alive with weevils, and the wheat is also badly eaten. There were also some samples of rice in the boxes, and these were weevilled. There were weevils inside and outside the tin boxes, but *only one* weevil could I find in the paper bags."

Moorshedabad pests.

A local report, together with some specimens of insect pests, has been received from the Collector of Moorshedabad through the Director of Agriculture, Bengal.

The following pests are noticed :—

1. Three kinds of insects which attack *kalai* (peas).
2. Insects which injure paddy by cutting the blades.
3. *Nagore-chand*, which occasionally damage rabi crops, both by eating the shoots of the young plants, and also by eating the seeds.
4. *Jaba*, attack rice and other crops, eating the young leaves. They appear in considerable numbers, and in a field that they attack they sometimes destroy as much as half the crop.
5. *Gaudhi*, resemble mosquitoes ; they suck the milk out of the ears of young paddy of the early crop, late paddy escaping.
6. *Bajarmari*, a small blackish insect, which appears in years of high flood and eats the leaves of paddy.
7. *Bamani*, black insects, which eat paddy ; they are of the size of large peas.
8. *Faring fly*, black insects, marked with red, which eat the leaves of paddy, and also of trees and other plants.
9. *Kora poka*, a white insect, about one inch in length, found in swampy land ; it destroys paddy seedlings, and also wheat and other rabi crops, by cutting them off at the roots.

The specimens marked as *kalai* pests were found to be the larvæ of moths belonging to the groups Sphinges, Bombyces, and Geometres, besides larvæ of Curculionid beetles and of Diptera ; none of these can be precisely determined at present without an examination of mature specimens. Besides the *kalai* insects, specimens were found of two species of *Acrididæ* (grasshoppers), and of *Leptocorisa acuta* (the Rice Sapper), described in Economic Notes, I, No. 1.

Monghyr pests.

The Subdivisional Officer of Beguserai, Monghyr, has forwarded specimens of two insect pests known locally as *Kajra* and *Hariharha*. He reports that they devour the seed-pods and are specially injurious to the rabi (or spring crops), usually appearing when the wind blows from the east, no remedies being adopted to remove or destroy them, though they often disappear of themselves, generally after a shower of rain or other atmospheric change. He has also forwarded dried specimens of the pests known locally as *Bundri*, *Larka*, and *Bhua*, with the information that they injure rabi crops.

The specimens marked *Kajra* prove on examination to be the larvæ of a Noctues moth, identical with, or very closely allied to, *Heliothis armigera*, the *Cotton Ball Worm* of America.

For the absolute determination, however, of the species, specimens of the moth should be obtained. On p. 50 of I, No. 1 of these *Notes*, it is recorded that the pest which attacked the seed capsules of the opium poppy in Patna in 1879, and which was undoubtedly *Heliothis armigera*, was known locally as *Kujra*; it may be inferred therefore that this is the insect in question. In a report forwarded by the Collector of Monghyr in 1888 (quoted on p. 75 of I, No. 1 of these *Notes*) the *Kajra* is noticed as the most terrible pest to crops in that district, where it eats up, not only paddy, but also all the rabi crops. A short general account of *Heliothis armigera* is also given (*ibid.*).

Of the other pests forwarded, the specimens marked *Hariharha*, *Bundri*, and *Larka* are obscure larvæ of moths belonging to the groups Noctues and Geometres, while the specimens marked *Bhua* are the larvæ of a Bombyces moth. For the precise determination of all these insects, however, well-preserved specimens of the moths, into which the larvæ transform, are required, the caterpillar being too obscure to make anything of.

Midnapore pests.

In a local report forwarded by the Director of Agriculture, Bengal, from the Collector of Midnapore, "red-ants and white-ants, with black mouths," are noticed as having this year proved destructive to the potato crop,—the fields manured with bone meal being less injured than those manured with cow-dung and oil-cake.

The people are said usually to apply turmeric water for these pests, but it is not always found to be successful. Khesari (pulse) was damaged by samll green insects, the leaves in the first instance showing black spots and afterwards appearing as if scorched by fire.

Patna pests.

The following insects, said to be pests, were received on 14th March 1889 from the Collector of Patna, through the Director of Agriculture, Bengal. The leaves and seeds, forwarded as belonging to the plants attacked, were submitted to Dr. George King, who kindly determined their specific names. No further information accompanied the specimens.

"1. Specimens of the Noctues moth *Leucania extranea*, said to attack the pea (*Pisum sativum*, Linn.); also a Tachinid fly, which is no doubt parasitic upon the moth.

"2. Specimens of the Noctues moth *Agrotis suffusa*, said to attack the leguminous plant *Lathyrus sativus*, Linn.

"3. A moth which is probably *Plusia nigrisigma* (Noctues), said to attack the gram plant (*Licer arietinum*, Linn.).

"4. A micro-lepidopterous insect, not precisely determined, said to attack the lentil (*Ervum lens*).

"5. Specimens of leguminous seeds in earth, without any sign of insects.

"6. Some small obscure heterocerous larvæ which cannot be precisely determined without specimens of the moths into which they transform. No botanical specimens accompanied these larvæ."

Further specimens, and also a practical account of the pests, are desired, so that a more complete record may be furnished for reference.

Further Patna pests.

Some caterpillars have been received through the Director of Land Records and Agriculture, Bengal, from the Officiating District Engineer of Patna, with the information that the ones which are known locally as *Lurka* attack grains, such as *khessari* (*Lathyrus sativus*) during the months of January and February. The local report remarks that they appear "whenever an east wind blows, especially during cloudy weather." The specimens marked *Lurka* were found to comprise obscure larvæ of several species of small Heterocera, amongst which the only species that could be determined precisely from the material was *Heliothis armigera* (p. 97), one of the larvæ of this species being found with its body half inserted in a full-grown *khessari* pod, into which it had bored in the manner characteristic of the species.

The remaining insects, known locally as *kira*, which were said to eat *arhar* (*Cajanus indicus*), *kerao* (a small field-pea), &c., during the winter months, were found to be obscure heterocerous larvæ, which cannot be precisely determined without specimens of the moths into which they transform.

Madras turmeric pests.

Specimens were received, on 21st February 1889, from the Board of Revenue, Madras, through the Superintendent, Government Central Museum, Madras.

"(1) *Sutta thegulu*, small black-winged insect, frequently jumps from one place to another. This attacks the plants when two months old. The leaves become rolled up, greenish in colour, turning pale yellow, and the leaves gradually become dry. This spoils the turmeric crop, and rhizomes are not developed. Eggs are also deposited on the back of the leaves. *Sutta thegulu* is considered to be a severe form of attack."

This pest, *Thrips sp.*, belongs to a group of insects well known in Europe and America as garden pests. It has been found (*vide* Report of the United States Entomologist) that the species which attacks the flowers of orange trees in America can be destroyed by spraying the flowers, either with whale oil soap solution (one lb. of soap to four or five gallons of water), or with Pyrethrum wash (an ounce of Pyrethrum mixed with a gallon of water), and it is probable that the same treatment will be found effectual in the case of the Madras species.

Particulars of any experiments that may be made with a view of destroying this pest in the Madras Presidency will be of interest in

connection with the investigation of the economic insects of India which has been undertaken by the Trustees of the Indian Museum.

"(2). *Bobhadala.* It is a milder attack. No insect is found. The leaf is not altogether deprived of its greenish tint, but some parts of the leaf in small patches become pale yellow and gradually dry up. This form of attack is found when the plants are three or four months old. By this the outturn is not altogether lost, as in the preceding case; but it is reduced to one half."

No insects could be found on the leaf forwarded as attacked by this pest.

Pests—the Bangalore Public Garden.

Mr. J. Cameron writes (16th January 1889) :—

"We have been trying experiments in the cultivation of mahogany, and I observed some weeks ago that the leaves of our young trees were much eaten by this insect. In fact some score of the plants were quite denuded of foliage."

The insects forwarded were found to be the larvæ of a species of Bombyces moths belonging to the family *Limacodidæ*. Specimens of the moth are necessary for the precise determination of this insect.

Mr. Cameron adds—

"We have not been troubled this season by the Lemon Tree Pest (*Papilio erithonius*), nor by the Pyrales moth, which committed such havoc to our lawns in November 1887."

Champaran pests.

The local report, dated 9th April 1889, received through the Director of Agriculture, Bengal, from the Collector of Champaran, is as follows :—

"Of the gentlemen consulted on the subject, I have received replies from a few leading indigo-planters, and have thus been able to collect the following information.

"There are insects of various descriptions which cause damage to crops at various stages of growth, but the following are known to be the most injurious and to appear more frequently than others.

"1. *Bherooahs.*—A kind of beetle chiefly found in high light lands, travelling along just underneath the surface of the ground and cutting the roots of the crops. A good ploughing in April and May, or hoeing, is of benefit in destroying them (one cannot do that, however, with indigo, and it accordingly suffers greatly).

"2. *Grasshoppers.*—These are very destructive to any crop sown after the weather gets warm, say in April. Indigo then sown is sometimes completely cleared off. *China* (*Panicum frumentaceum*, small millet?), a native crop, also suffers, as does *Moong* (*Phaseolus mungo*, pulse?), and paddy.

"3. *Caterpillars.*—These sometimes come in swarms and demolish all the leaves of the indigo crop. Sometimes, when the plant is young and the nights are cold in March, the appearance of caterpillars is marked by a kind of blight first coming, and forming a web which seems to stick the leaves together and the caterpillar then forms. Again, when the plant is fully ripe and fit for cutting, they appear and do much damage by clearing off the leaves wholesale.

"4. *Locusts* might be added; only fortunately their visits are rare.

"5. A species of beetle, red and yellow, with black spots, is most destructive to flowers; it appears chiefly to attack the Hybiscus, but it is also partial to roses and other flowers.

"I have obtained a few specimens of caterpillars and forward them separately. I will continue enquiries on this subject, and will furnish you with any further information which I may be able to gather hereafter."

The specimens that are mentioned were received in such bad condition that little could be made of them. They consisted of the pupæ of a small dipterous insect, besides a few broken remains of the chrysalid of a small moth. This material is altogether insufficient, and fresh specimens of all the pests should be sent to the Indian Museum. Specimens in all stages of development (including the moth) of the pest known as the Indigo Caterpillar, are specially desired: they should be accompanied by any information that can be obtained about the pest, which would seem to occasion serious injury to indigo.

Cawnpore pests.

Specimens of the following have been received from the Director, Land Records and Agriculture, North-Western Provinces. The forwarding letter is dated 3rd April 1889.

"(1) *Mahun* or *Champa*, reported as a very minute insect, which chiefly infests leguminous plants. This is one of the Aphidæ.

"(2) *Demak* (white-ants.—*Termes sp.*)

"(3) *Makoha*, reported as doing considerable injury to *Jowar* (*Sorghum vulgare*) when it is young. This the larva of a small moth, possibly the *Jowaree Borer* described in I, No. 1 of these Notes, but the specimen is too obscure and decayed for precise determination."

Further Cawnpore pests.

From the Director of Agriculture, North-Western Provinces, has been received a series of insects said to be destructive to crops, but without any definite information as to the extent and nature of the injury done by each species. The series comprises a good many species, represented by larvæ only. The following may be noticed:—An Orthopterous insect, said to devour the leaves of indigo plants; this species probably belongs to the genus *Crotogonus*. It has previously been sent to the Museum as destructive to indigo, but little is known about it; specimens have been sent to Europe for precise determination. Two Hemipterous insects, determined by Mr. E. T. Atkinson as *Dysdercus cingulatus* and *Apines concinna*,[1] and a large number of the larvæ of various obscure Heterocera, which cannot be determined without an examination of the moths into which the larvæ transform.

Precise information is desired as to the extent and nature of the injury done by the various insects that have been sent; and the information should, wherever possible, be accompanied with specimens of the fully-developed forms,—larvæ, especially in the case of obscure Heterocera and Coleoptera, being generally indeterminable.

[1] For Mr. Atkinson's note on those species see pp. 126 & 127.

XI.—INSECTICIDES.

London Purple.

Mr. W. Gollan, the Superintendent of the Government Botanical Gardens, Saharanpur, North-Western Provinces, reports as follows on some of the London Purple Insecticide, sent to the Indian Museum for experiment by Messrs. Hemingway & Co., of 60, Mark Lane, London, E.C., and also on a force pump, similarly sent to the Indian Museum for experiment by Messrs. Rumsey & Co., of Seneca Falls, New York. The pump is that described as No. 267 in Messrs. Rumsey's Catalogue, and is intended for distributing insecticides.

"*Saharunpore, May 30th, 1889.*—I have the honour to send you the following brief account of a few experiments made here with the spray pump and London Purple sent me for trial.

"I mixed the London Purple with water in the proportions named in the printed directions issued by Hemingway's London Purple Company, Limited, and as a first experiment sprayed it through the force pump upon a crop of hot-season cucumbers attacked with a kind of flying beetle, specimens of which I am sending you in spirit.[1] The result, however, was disappointing, as the beetles flew away to neighbouring plots of cucurbitaceous vegetables, apparently none the worse for the spraying they had received. They have not since settled on the plot sprayed upon in the same numbers as before, but they are still present; therefore this substance cannot be considered an effective insecticide for this particular kind of beetle.

"The next experiment tried was upon the mango Cicadid,[2] and in this instance the result was a complete success. Some of our mango trees were covered with hundreds of thousands of this insect, but after one spraying only a few hundreds were noticeable, and after a second spraying scarcely any were to be seen. I sprayed the first few trees in the evening, but afterwards found it was a better plan to do this at night by lamp-light. When the operation of spraying is done during day-light, the insects fly before the pump and settle on neighbouring trees, but when done at night they remain where they have settled, and in every instance where the London Purple reached them the result appears to have been certain death. London Purple may therefore be recommended as a sure and certain insecticide for the destruction of the mango Cicadid or fly.

"The last experiment tried was upon the caterpillar [3] I previously wrote to you about, and which has proved so destructive to our young-budded oranges. I do not know its name, but it is the larva of a butterfly, as you surmised, and as I am sending you the insect in all its stages, I have no doubt you will be able to name it. The London Purple in this case was also a complete success. Owing to previous hand-picking there were only a few caterpillars on the trees when sprayed upon, but the few noticeable were destroyed with one application, and none have since appeared.

"The force pump worked admirably, and is well fitted for what it is intended for.

"I can find no other pests at present for further experiment, but others will appear during the season, and I shall therefore continue my experiments as opportunity offers and communicate the results."

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[1] The beetle proves to be *Aulacophora abdominalis*, Hope, which is mentioned on pages 64 and 68 of No. 1 of these Notes. Mr. Gollan reports it as destructive to all Cucurbitaceæ.

[2] *Idiocerus sp.*, for an account of which see page 4 of No. 1 of these Notes.

[3] *Papilio erithonius*, for an account of which see page 93.

A possible insecticide.

The following is an abstract taken from Dr. Watt's Note published in *Selections from the Records of the Government of India, Revenue and Agricultural Department,* I, (1) 8, 1888-89 :—*Adhatoda vasica* (*Adoolsa*), a common wild plant, which occurs all over India, and is reputed to kill weeds and insects, besides being generally recognised as a valuable manure. It is also supposed to hasten the germination and the ripening of fruits, and has a high reputation as a medicine for coughs and lung diseases generally. A number of reports from different localities on this plant are given, but the insecticide property is only noticed in two, and does not appear to be established with any certainty.

The Conservator of Forests, Northern Circle, Bombay, writes (August 1887)—

"I am aware that it is used for *rab* in the ordinary way for rice-fields, and that the leaves are much prized for their manurial value in connection with the cultivation of vegetables and fruit; and, moreover, that an infusion of *Adoolsa* and tomato leaves, combined, is applied to cabbages, *knolkhol*, and other vegetables, in order to kill the insects which feed upon the young seedlings."

In the Proceedings of the Board of Revenue, Madras, No. 166, dated 10th April 1888, the Collector of Nellore states that natives place the leaves of *Adoolsa* among clothes to keep off insects.

XII.—A REMEDY FOR COFFEE SCALE.

Kerosine emulsion, which has long been in use in America as an insecticide, and which on several occasions[1] has been suggested for use in India against pests allied to those for which it has been found effective in America, is now gradually becoming recognised as a practical remedy against the "Green Scale Bug" (*Lecanum viride*) which attacks coffee plants in South India and Ceylon. From Mr. R. H. Morris's experiments,[2] carried out last year in the Nilgiris, there seemed every probability that kerosine emulsion could be effectively employed against the pest; and information has now been received of its having been successfully used in Ceylon over a sufficiently large area to test its practical applicability.

In the beginning of the present year (1889) Mr. E. E. Green, of Ceylon, wrote[3] that Green Scale "has practically wiped out coffee cultivation in many districts. Its vigour, and the rapidity with which it is propagated, have defied any remedial measures that we could afford to apply, and consequently planters are everywhere turning their attention to the cultivation of tea in the place of coffee." This account would

[1] Journ. Agri. Hort. Soc. Ind., Vol VIII, pt. II, new series; also *Notes on Economic Entomology*, No. 2.

[2] Recorded in *Indian Museum Notes*, Vol. I, No. I, page 49.

[3] Insect Life, March 1889, No. 9, page 293.

seem to represent, not unfairly, the hopeless view taken by the planting community upon the subject. The introduction of a practical remedy is therefore a matter of great importance, and if kerosine emulsion turns out to be as successful as the experiments with it seem to promise, a pratical remedy has at last been found.

In the case of 285 acres of coffee upon which kerosine emulsion has been employed by Mr. W. Jackson of Ceylon (see his letter below) the pest has been successfully kept down at a total cost of about ten rupees eight annas per acre per annum (including about three rupees per acre spent upon lime that was used as manure to strengthen the plants), at which cost it is estimated that it pays to adopt the treatment.[1] Mr. Jackson found that while coffee that was treated with the insecticide was cleared of the pest, equally good coffee, growing close by and well manured, but not treated with insecticide, was so much damaged by the pest that it utterly failed to keep its condition or to ripen its crop. The plan adopted was to rub over the affected parts of each plant with a piece of cloth soaked in the emulsion, the work being done by coolies. This is obviously a most tedious process, and experience of American Entomologists [2] in Florida has shown that by far the most effective method of applying the insecticide is by spraying it in a cloud of fine spray by means of force pumps and spray nozzles. Out of a total of about seven rupees eight annas actually spent upon the insecticide treatment per acre, the cost of the emulsion used by Mr. Jackson amounted to only about eight annas per acre, while the labour of applying it cost about seven rupees per acre ; labour is therefore by far the heaviest item, and as there is every probability that the labour will be materially lessened by the use of force pumps and spray nozzles, it is anticipated that the present cost of the treatment will be much reduced.

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[1] Mr. Jackson has since written : " Just a line as regards the *cost* which I gave you for the kerosine emulsion. I see you have reduced my figures to so much per acre, and this, without some explanation, might be misleading. I started with the object that it should be a case of ' hands off ' with the bug all through the *good* coffee, and I simply give, in response to your call, just what it cost us to do this sufficiently to help the coffee to bear the crop then upon the trees, which was a good one, and to keep up as much as possible its condition and prevent the bug spreading. I should say that, perhaps, two thirds of the total acreage, more or less, was affected by the bug in all stages, and the balance had little or none at all, and that only the affected trees were operated upon ; the others were passed over and small gangs of coolies kept to watch for any after attack. If *all* the coffee had been badly attacked with bug it would have cost much more than it did, and again the work done easily in the season when the young bug is more easily removed will cost less than when done later on, &c. Of course, those who, like ourselves, have carried on this treatment—and there are of course a number who have done so (and no doubt with equal results under similar circumstances)—would understand why total cost was given over all coffee fixed upon to be kept clean, &c."—(*Ceylon Observer, 26th June 1889.*)

[2] Notably Messrs. Riley and Hubbard.

Besides reducing the labour of applying the insecticide, force pumps have the further advantage of facilitating the intimate mixture of the soap solution with the kerosine—a condition which, while absolutely essential for the efficacy of the emulsion, is very difficult to obtain by hand.

The nozzle that is used for spraying the emulsion should be such as to give a cloud of fine spray; this is most important, not only because the same amount of emulsion goes much further when sprayed in a cloud than when sprinkled in drops, but also because a cloud of fine spray has been found to be much more effective than even a heavy drenching in destroying the pest. Dr. Riley supposes that this is because the particles of fine spray adhere, and the whole of the emulsion is thus utilised, while, on the other hand, large drops rapidly run off, carrying most of the kerosine with them, and leaving little but water behind upon the plant.

The eggs of scale insects have been found to be harder to kill than are the larval and adult forms; two or more light sprayings at intervals have been found therefore far more effective than a single heavier application: for the first application kills the larvæ and mature insects, and the subsequent ones destroy the larvæ that emerge from eggs that have survived the previous treatment. In this connection it is important to ascertain the time that the eggs take to hatch, and also the time required for the growth of the larvæ, before they are themselves able to lay eggs; the object being to make the intervals of time between the sprayings; just long enough to allow all the eggs, that withstand the first application, to hatch out before the second application, while at the same time not permitting any of these larvæ to become full grown and to deposit eggs of their own.

An account of the force pumps and spray nozzles that are recommended for applying the emulsion is given in *Notes on Economic Entomology*, No. 2 (1888); also in Indian Museum Notes, Vol. I, No. 1, p. 49. The following extract, however, is appended for convenience of reference:—

"The emulsion is made by mixing two parts of kerosine oil with one part of soap solution or milk (the soap solution being made by dissolving from a quarter to one pound of common soap, or whale oil soap, in one gallon of water). The whole is violently churned at a temperature of about 100° Fahrenheit, by driving it backwards and forwards through the spray nozzle of a force pump. The emulsion thus formed is diluted with water:—that found successful in the Nilgiris was made with common soap and was diluted, with nine parts of water to one part of the mixture. The wash is applied by spraying it over the affected coffee bushes, and for this purpose an ordinary force pump may be used, but it should be fitted with a nozzle that gives a finely divided spray. Probably the best nozzle for the purpose is what is known as the cyclone or eddy nozzle, consisting of a small circular chamber, with two flat sides, the inlet through which the liquid is forced by the pump being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid, which issues in a funnel-shaped spray through the central outlet in one of the flat sides of the circular chamber."

The following is Mr. Jackson's account of the treatment he has adopted; it was published in *the Ceylon Observer* of 17th June 1889 :—

"I have already gone through a deal of correspondence about my treatment for Green Bug, and a good many have been over at different times and seen the results for themselves.

"I read the letter of Mr. Cotes with much interest and was quite prepared to hear that the 'Kerosine Emulsion' had destroyed the bug wherever it was applied; but I have certainly no experience myself beyond this :—nothing that I have tried has succeeded by first application in both destroying the bug and keeping it away for the future. With me it has regularly returned each season fat and flourishing; but I am glad to say it has not spread so rapidly or to the same extent the last two seasons as previously, and that the trees treated for bug seem to stand the attacks better now than at first; and I think it probable that the pest will gradually leave us. I notice you say that 'good results were obtained for a time, yet experience did not prove it to be such a case as would warrant general application or repay all the outlay.' I really do not know how you arrive at such conclusions; for, whatever doubt there may have been in the early experimental stage, there can be no doubt now that the treatment carried out on these estates has been very successful. The *cost* has been anything but excessive and perhaps much less than many would think.

"The first year's cost was the heaviest, and I give actual figures of this on one of the estates as follows :—

"187 acres, a lot of coffee besides in tea :—labour cost R1,322·81; lime cost R453·39; kerosine oil and soap, &c., cost R82·98 : total R1,859·18.

"On another estate it was—98 acres, and a lot of coffee in tea :—labour cost R710·27; lime cost R428·71; kerosine emulsion cost R59·01 : total R1,197·97.

"This is for the full twelve months, which means two general attacks upon all affected trees right through, and then several gangs of coolies being kept on to watch for any return of the bug and to wash it off wherever it appears.

"This year the cost is considerably less. The lime is altogether an extra, but I have found it very beneficial to the trees after being treated for bug, and it helps both to ripen up the crop and to keep up the condition of the tree. The above 285 acres are well-cultivated coffee, and have been regularly manured. I found, however, that the highest cultivation of itself could not withstand the severe attack of bug which we had at first, and that equally good coffee, side by side with these 187 acres and 98 acres, to which we did not apply the kerosine emulsion, but which had extra manuring, utterly failed to keep its condition or to ripen its crop to any extent.

"The application in my case is a very simple one. The cooly has a rough piece of cloth which he soaks in the kerosine oil mixture and rubs over the bug wherever it is to be found (I do not wash the stems of the trees), and this means sudden death. In the early life of the young bug, I have found even water will remove it; but when older, it takes a good strong rub to unhinge it. The details of application are easily worked out, each one for himself. I believe a great deal of valuable coffee might have been saved had the kerosine emulsion been carried on more generally.

"The difficulty at present is to spare labour with such demands as tea makes upon us just about the time that the bug begins to put in an appearance : so that any plan giving equally good results, which could reduce the labour required, even at an increased cost, might be valuable."

The following is Mr. Green's account of Scale insects in connection with coffee; it was published in Ceylon in 1886, and is reprinted here,

with the permission of the author, for convenience of reference. The figures in plate VII are taken from the lithographed drawings that accompanied his paper.

"*Life-history of the Green-scale Bug* (*Lecanium viride*).—The insects appear as small, oval, green scales, clustered thickly, chiefly upon the under surfaces of the leaves and upon the young shoots of the coffee tree. The full-grown female measures about one eighth of an inch in length and about half as much in breadth. On the upper surface the eyes are visible as two small black spots at one end, which is the head of the insect, and is nearly always pointed towards the stalk of the leaf. The insect is provided with one pair of antennæ, three pairs of short legs, and a very fine hair-like sucking tube, situated between the front pair of legs.

"The eggs, which vary in number, but are seldom more than twenty, are hidden by the body of the living insect, and are hatched in that position. The young larva is only visible to the naked eye as a minute speck. It is very active, and moves freely from leaf to leaf, deserting the old and spreading over the young shoots, where it finally settles itself, and soon developes the scale characteristic of the mature insect.

"It is in this early larval stage, probably, that the pest is chiefly propagated, as besides its own powers of locomotion, it is liable to be transported by wind, in the feathers of birds, and upon coolies' clothing. This last is probably the chief agent by which it is extended. The young insect (as I have proved by experiment) will live for many days without food, and might easily be unconsciously transported from one district to another over considerable distances.

"The male insect is at present unknown. It is probable that the insects now existing, though externally resembling the female form, are asexual, and that their broods are produced by the phenomenon known as 'Parthenogenesis,' by which several successive generations are fertile without the aid of the male element (as is known to occur in the development of Aphis and a few allied insects). Professor Huxley states that 'the number of successive broods has no certain limit, but is, so far as we know at present, controlled only by temperature and the supply of food.' (Linns., XXII., page 198.)

"*Distinction between present and former Black Bug.*—Mr. Neitner, in his 'Observationson the Natural History of the Enemies of the Coffee Tree,' describes two species of Scale Bug under the names of *Lecanium coffeæ* (Brown or Scaly Bug) and *Lecanium nigrum* (Black Bug). It was the first of these two that in former years was chiefly destructive to coffee. The present species, which I have called in distinction *Lecanium viride* (Green Scale Bug), differs from the other two in many particulars.

Colour of eggs of *L. viride* . . .	Pale green.
Ditto ditto *L. coffeæ* . . .	Pale red.
Ditto ditto *L. nigrum* . . .	Pale red.
Colour of half-grown larva of *L. viride* .	Pale green.
Ditto ditto *L. coffeæ* .	Pale brown to crimson.
Ditto ditto *L. nigrum* .	Yellow to dull orange.
Colour of mature insect, *L. viride* . .	Bright green.
Ditto ditto *L. coffeæ* . .	Yellow-grey to brown.
Ditto ditto *L. nigrum* . .	Reddish brown to black.

"The individuals of *L. viride* are densely packed, frequently overlapping each other along the mid-rib and veins upon the under surface of the coffee leaves, and occasionally upon the upper surface also. The head of each insect is pointed towards the base of the leaf or shoot upon which it is placed.

"The groups of *L. coffeæ* are indiscriminately scattered over the under surface of the leaves and upon the young branches, apparently without any definite arrangement.

"The colonies of *L. nigrum* are similarly placed, but are seldom found in large numbers upon coffee.

"The eggs of *L. viride* are hatched under the body, and during the life of the parent insect, which possibly produces several successive broods.[1] This may account for the greater numbers and destructiveness of the species under notice.

"The eggs of both *L. Coffeæ* and *L nigrum* are not hatched until after the death of the parent insect, whose body shrivels internally, while the external scale becomes firmly attached to its support, and forms a protection to the eggs and young larvæ.

"In form and size, also, the three species differ considerably. The scaleof *L. viride* is nearly twice as long as it is broad, while the greatest thickness is less than half the breadth of the insect.

"The scale of *L. coffeæ* is only slightly longer than it is broad, and the thickness is equal to the breadth. *L. nigrum* is the largest insect of the three. The length of its scale is nearly twice, and the thickness two thirds of, its breadth.

"The habits of all three species are similar, in so far that they absorb the juices of the tree, thereby diminishing its vitality. But there seems to be a general opinion that the present form of the pest is very much more fatal and rapid in its effect upon the coffee than was the 'black bug' that chiefly attracted attention in former years.

"*Effect of the Green-scale Bug upon Coffee.*—The Green Bug appears to attack with indifference both healthy and unhealthy trees, but the latter show its effects the soonest. It breaks out on individual trees, often in remote parts of an estate, probably where some individual has been deposited by one of the many agencies that are concerned in its distribution. Starting from these centres, the bug soon spreads over the surrounding coffee.

"Well-grown and robust coffee trees, situated in sheltered hollows in deep, rich soil, appear to be least affected by the attacks of the bug. Although the leaves become infested with the insect, and blackened by the consequent fungus, they do not entirely fall off, as is generally the case when poorer coffee is attacked. In this latter case, not only are the trees entirely denuded of leaves, but the shoots become dry and hide-bound, no fresh wood being formed. In favorable situations the trees continue to put out fresh leaves, and, excepting the presence of the black fungus, retain a fairly healthy appearance. This black fungus vegetates upon the 'honey-dew' always found upon leaves infested with bug or Aphides, and considered to be the excrement of these insects.

"After its period of growth is complete, the fungus peels off in large flakes, leaving the leaf clean, and with its natural polished appearance, proving that the rootlets of the fungus do not enter the tissue of the leaf. From the fact that the greater number of the stomata, or breathing pores, are situated upon the under surfaces of the leaves and that the fungus is confined to their upper surfaces, upon which the 'honey-dew' is deposited, it is probable that the injury received by the tree is due chiefly to the loss of sap absorbed by the bug itself, and is not connected with the presence of the fungus, unless, as suggested by Mr. Nietner, the decomposition of the carbonic acid of the atmosphere is interrupted by the intervening membrane.

"*Results of manuring and liberal cultivation.*—This new pest, coming at a time when coffee is to a large extent being replaced by tea, has attracted less public attention than would otherwise have been paid to it. In the generality of cases the presence of the bug upon an estate has merely hastened the change of products. Many proprietors and planters, alarmed at the rapid destruction caused by the pest, have

[1] Since writing the above, I have found immature eggs inside the body of the parent insect after the first brood has been hatched.

naturally hesitated to risk expenditure upon manuring or cultivation in any form. Within my own very limited experience I have found that manure (either cattle or artificial) has been of use only where the trees have not quickly succumbed to the effects of the bug. On poor soil the trees seem to be permanently injured upon the first appearance of the pest, and manure entirely fails to revive them. But where the symptoms have been more gradual, manure seems to have a sustaining effect, and to assist the tree to bear the heavy tax imposed upon it.

"Lopping off the lower primaries naturally throws a greater amount of sap into the remaining branches, and is generally followed by a decided improvement in the appearance of the coffee.

"*Will trees badly attacked by the Bug, eventually throw it off and survive?*—It is difficult to obtain reliable information upon this question; but there seems to be no doubt that in some few cases the pest has disappeared from once badly-infested coffee.

"I have been told of an estate in Mátalé that was reported to have been absolutely killed out by the bug; but when my informant himself visited this place early in 1885, he found one stretch of fine fresh foliage from end to end, and no bug on any part of it.

"A similar case has recently occurred within my own observation. A field of coffee, which was very badly infested with bug last year (1885), is now (November 1886) entirely free from the pest. I have carefully and extensively examined the coffee in this field, and have been unable to find a living specimen of the insect in any stage. The change has but recently taken place, the remains of the black fungus being still present. It is too early yet to say whether the coffee will recover its former vigour, but its present condition leads me to hope that it will do so.

"A planter writes from Badulla:—'Green Bug has spread in some places, but has nearly disappeared from others which were originally attacked, leaving the trees unhealthy and black, but slowly recovering themselves.'

"The possibility of recovery in such cases will probably depend upon the amount of cultivation bestowed upon the coffee for the few years previous to the attack, and upon the nature of the soil in which the trees are situated. Many estates upon which there is said to have been no recovery, even in appearance, had been practically abandoned for several years previous to the advent of the bug.

"During some months each year the bug appears to remain dormant. The insect in all its stages is still present, but not in such extraordinary numbers; nor does it spread much at such times. Many of the insects die off and become enveloped in a white mould. This state generally occurs during very wet weather. Its period of activity appears to be dependent in some degree upon the amount of rainfall. I have noticed that the insect itself chiefly spreads during dry weather, though its extension is often not apparent until the first period of wet weather, as it is not till then that the fungus makes its appearance.

"*Proposed Remedies.*—A number of remedies have been confidently recommended. In some cases their application is quite impracticable; in many others, whatever may have been the result with the old bug, they have absolutely no effect upon the new Green Bug.

"One of the commonest and simplest of these so-called remedies is Mana grass. But I have been unable to note the slighest good effect from its application, either as a thatch upon the branches, bound round the stem, or spread upon the ground.

"I have found dry caustic lime equally useless as an insecticide, though its secondary effect as a soil-fertiliser may be sometimes evident by an improvement in the appearance of the coffee.

"The same remarks will apply to the use of wood ashes.

"Caustic lime, applied in the form of whitewash, is fatal to every insect that it actually touches, but it is impossible by this means to exterminate every individual on each tree; and a few escaping would be sufficient to reproduce the pest within a short time. The expense alone would make the work impracticable. Each separate coffee branch must be turned over and the mixture applied with an ordinary whitewash brush. A cooly is unable to finish more than twenty trees during the day; and I have found that even then the pest shortly returns, as a proof that the work has not been thorough.

"Mr. Nietner, in his notes upon 'The Enemies of the Coffee Tree,' remarks that 'the application of tar to the roots has been suggested, it being said that, taken up into the system of the tree, it throws off the bug. Although hitherto no important results have been achieved by carrying it out, this idea strikes me as a very valuable one: it is through the root of the tree the evil should be dealt with; but a substitute for tar should be sought for, more powerful and more deadly to the bug, but at the same time equally harmless to the tree.'

"Following out this idea, I have tried the solution of phenyle, brought into notice as an insecticide a few years ago. It is one of the extracts of coal tar, and probably contains most of its active properties in a form that can be more easily taken into the system of the tree. The mixture used consisted of one dessert-spoonful of phenyle to two quarts of water. The soil round the root of the tree was thoroughly broken up with a digging fork, and the liquid applied from an ordinary watering-can. My experiment was limited to a single tree, and scarcely a sufficient time has elapsed to judge of its success. But it has seemed to me that the pest upon the tree has been gradually disappearing, although the surrounding trees have not altered their condition.[1]

"To the roots of another tree I applied half an ounce of napthaline (another extract of tar), but I have not detected any beneficial effect in this case.

"With the idea that an injection might be more rapid in its action, I drilled holes with a half-inch auger into the stems of several trees, some of which I filled with common tar, others with pure phenyle; but this treatment has produced no apparent result.

"The Scale Bug being allied to the Phylloxera, which attacks grape vine, it is possible that similar remedies might be effective. In the *Tropical Agriculturist* of February 1885, is an extract from the *Planter's Gazette*, which states that 'a means has been discovered of overcoming the Phylloxera by an easy and inexpensive treatment, the basis of which is an arsenical solution mixed with cinders. The limited experiments made with this preparation seem to have been attended with admirable results.'

"The following extract from an Indian paper describes a successful remedy for insect blights upon paddy and other plants. I have been unable to obtain any of the Koonri oil-cake in Ceylon, but it could possibly be obtained from India for experiment. The extract is as follows:—'Mr. J. Dumaine lately suggested that fumigating with Mowha oil-cake, if done immediately on the first appearance of insect pests while still affecting small areas, might be usefully tried by tea-planters and others.' He was asked to communicate his own experience, and writes as follows:—'*Koonri* oil-cake is made from the seed of the mowha (*Bassia latifolia*), from which the oil has been expressed. I was

[1] *December 31st.*—After an interval of a month I now find that this tree has entirely thrown off the bug, although on neighbouring trees the pest has rather increased than otherwise.

13th July 1889.—Mr. Green writes: "Please note that I am not satisfied that the phenyle treatment is of any real value—other trials do not seem to have been equally successful—and the beneficial results, at first noticed, may have been due to some other unsuspected cause. I think the kerosine emulsion, used with a really economical distributer, is the most promising remedy yet suggested; and I think this treatment will be equally valuable for tea, to be used immediately after pruning, for the destruction of *Aspidiotus* and other scale insects on the stems."

given to understand that the smoke from it, when burned in a house, was sure death to all kinds of insects. This gave me the idea of trying it in the open air. Some of my paddy, rahar, and moongdall, having been attacked by blights, I gave it a fair trial, which proved a success. I got a number of ordinary handies, and filled them three quarters full with dry cowdung, and, after, firing filled up with *Koonri* oil-cake. The handies were then distributed on the windward side of the affected fields. The wind that day was nominal, and the smoke was very great, and I can certify that none of the blights outlived the operation. The plants were in no way affected. The cost of the oil-cake is ₹4 to ₹8 a maund, delivered at Howrah Station, exclusive of bags, and it is only procurable at a certain time of the year.'

"I have just now been favoured with the following account of a treatment which is said to have been successful in destroying the bug upon an estate in Lindula:—

"'Fifteen per cent. carbolic lime (the mixture recommended by Schrotky as a cure for leaf-disease) was used. The powder was forcibly thrown up under the leaves by hand, when the trees were wet with dew. About three bushels were applied per acre. In ten days after the application the bug is said to have turned white and died; and now after three months' time, the coffee is looking remarkably healthy. On another estate where a weaker mixture was used, there was no result.'

"*Parasites of the Green Bug.*—The Green Bug is preyed upon by a number of insect parasites, the most important of which is a small mite (*Acarus*). These minute animals may be seen on almost any leaf affected with the bug, and may be distinguished from the young of that insect by their more rapid movements. Their numbers appear to me to have increased considerably of late, and I have noticed large colonies of the bug entirely destroyed by their means.

"I have noticed four or five species of beetles, belonging to the 'Ladybird' family, that eagerly devour the bug, and from their numbers must do great execution.

"Another useful ally is the larva of a 'Lace-wing' fly, a neuropterous insect. This larva, after sucking out all the juices of the bug, cements its empty shell, together with those of former victims, into a covering, which it carries about on its back, and in which it finally changes into a pupa, preparatory to its appearance as a perfect fly.

"Besides these external parasites, the bug falls a prey to the attacks of numerous minute ichneumon wasps, which pass their larval stage as small maggots, living inside the body, and gradually devouring the substance of their host.

"At certain seasons large numbers of the bug may be found dead and enveloped in a white mould-like fungus. It is uncertain whether this fungus attacks and destroys the living insects, or makes its appearance after the bug has been injured by one of its animal parasites. It is possible that the disease may be analogous to those parasitical fungi which affect the common housefly, the larva of the cockchafer, and the silkworm.

"Looking at the persistent increase of the bug, it may be thought that these parasites are of little or no use in checking it. But it must be remembered that this particular pest is a comparatively recent introduction, and that it would necessarily take some time before its enemies could increase in such a manner as to restore the balance of nature. The case appears to have been the same with the former 'Black Bug,' which spread rapidly, and was very destructive for a certain period; whereas now it is scarcely ever found, except on single isolated trees. Similarly, the cockchafer grub had its period for several years in various districts, and afterwards subsided as suddenly as it came.

"*Origin of the Pest.*—The Green Bug appears to have first attracted serious attention in 1882, when it was already doing considerable damage in Mátalé. I have been told by a planter of long experience that, in his opinion, it first came in with Liberian coffee, on which also it seems to thrive more luxuriantly than upon the Arabian

variety. In 1884 several estates in Pussellawa were badly attacked. The pest was noticed in Ramboda and Pundalu-oya early in 1885, and has now spread into Dimbula and Dikoya. It attracted attention in the Bandulla district about April of the present year (1886).

"This species of Scale Bug is not by any means confined to the coffee tree. I have found it flourishing upon *Cinchona succirubra*, *calisaya*, and *ledgeriana*, though it does not seem to injure any but the very young trees. I have frequently noticed it upon orange and lime trees, upon guava, and a large number of wild plants. I have occasionally seen it upon tea bushes, but not in sufficient quantities to affect the healthy growth of the plant.

"*Lecanium coffeæ.*—The original coffee bug occasionally attacks tea, and appears to be more injurious to this plant than is the Green Bug.

"*Lecanium nigrum.*—The Black Bug, though seldom found upon coffee, is sometimes present in large numbers upon the Croton-oil plant and the Ceara rubber, where it produces the usual effects, *viz.* a heavy fall of leaf and black fungus."

XIII.—ENTOMOLOGY IN THE INDIAN MUSEUM.

The following is a short report on the work done in the Entomology Section of the Indian Museum during the year ending 31st March 1889:—

Progress was made with the compilation of the *Catalogue of the Moths of India*, which comprises the synonymy and geographical distribution of all the Heterocera (moths) hitherto described from India, Burma, and Ceylon. Parts III, IV, and V were published by order of the Trustees, Part VI is now being printed off, and the Preface and General Index, which will complete the work, are in progress.[1]

During the year a sustained effort was made to get the Entomological Collections of the Museum examined and determined by European entomologists who have devoted special attention to particular sections of the vast subject of Indian entomology, this being the only practical way of getting the obscure species reliably determined, most of them as yet being not even sufficiently described. Collections were despatched to a number of gentlemen who generously came forward and placed their services gratuitously at the disposal of the museum, for the determination of the insects belonging to the special zoological groups in which they take interest. In this way the reliable determination of a large number of obscure specimens has been obtained, but very much remains to be done in the determination of species, before the museum will possess anything like an adequate set of named insects for comparison.

The investigation of the Economic Entomology of India, undertaken by the Indian Museum in conjunction with the Agricultural Departments, was, during the year, put upon a systematic footing, and a miscellaneous report on Indian insect pests was put into type and has since appeared as the first number of *Indian Museum Notes*. A very keen interest is being

[1] This work has since been completed.

taken in the work by a large number of correspondents in all parts of India, and specimens and practical reports have been received in large numbers.

Some success has attended the application of kerosine emulsion insecticide suggested for the destruction of the Green Coffee Scale insect *Lecanium viride* in South India, where practical experiments were tried by Mr. R. H. Morris; and arrangements are being made for having the insecticide apparatus, which has been sent to the Museum by American and English firms, experimented with practically in various parts of India, with a view to the publication of reliable information on the subject.

The number of Entomological specimens added to the Collections during the year amounts to 17,213, this being the largest number on record. A detailed list of accessions are being published in the Annual Report of the Museum, but the following are worthy of special notice:— the Hemiptera presented by Mr. E. T. Atkinson; the Hymenoptera, Diptera, and Hemiptera purchased from Mr. W. Doherty; the Buprestidæ presented by Mons. le Capitaine Kerremans; the Heterocera presented by Colonel Swinhoe; also the late Dr. F. Stoliczka's Yarkand Collections, which were received from Europe, whither they had been sent for examination.

Besides the general Entomological work, a series of fourteen collections, illustrative of Indian sericulture, were prepared for distribution, through the Government of India, Revenue and Agricultural Department, to various museums and institutions in India and Europe. Materials were also collected for the compilation of a general account of Indian silk-producing insects. Experiments were conducted with a view of elucidating the life-history of the Wheat Weevil. These experiments, which are fully detailed on p. 15 of No. 1 of *Indian Museum Notes*, confirm the theory that the weevil is a purely granary pest, and that grain can therefore be preserved by isolation and other precautions against infection, after it leaves the fields, the hard varieties of wheat being easily protected; while in the case of the soft varieties which offer less resistance to attack, protection from infection, though possible, is a matter of considerable difficulty.

Experimental rearing was attempted, with some success, in the cases of many of the insects sent to the Museum as injurious to crops, various stages in their growth being thus observed and preserved for future reference in the Museum.

A cross between the *Desi* silkworm of Bengal and the European *Bombyx mori* was reared experimentally, in the hot weather of 1888, from some remarkably fine stock bred by Mr. J. Cleghorn. The results seemed promising at the first, but the insects rapidly deteriorated, the mortality being so great in the third generation that the experiment was

abandoned. This confirms the generally entertained idea, which is that crosses between European and country worms (at least when reared in the way usual with Bengal silk-rearers) are of no commercial value. It was considered worth while to undertake the experiment, as Mr. Cleghorn's stock was distinctly finer than the Bengal variety, and if this superiority could have been maintained—a contingency which at first appeared to be by no means impossible—the stock would have been of very great value.

Experimental culture of the Italian bees, originally introduced by the late Mr. J. C. Douglas, was continued during the year. It was found that the bee can be reared in Calcutta, provided constant attention is bestowed upon it, but that without this contant attention, which it would be impossible to afford on any but an experimental scale, the bees die out rapidly. The Italian bee may therefore be considered as unsuited for introduction, and unlikely to be cultivated on a commercial scale in Lower Bengal. By artificial feeding and constant care, continued from the beginning of 1888 until well on into the rains, a very weak stock of Mr. Douglas's Italian bees, received from the Superintendent of the Alipur Jail, was brought into a flourishing condition; after this it was left pretty much to itself, as would be the case with bees reared commercially, the result being that already, in April 1889, though there is plenty of honey in the hive, the bees have nearly all perished, the chief mortality occurring in the cold weather.

NOTES ON RHYNCHOTA

BY

E. T. ATKINSON.

The *Kapási-poka* of Chuadanga, said to destroy cotton, is *Lohita grandis*, Gray, and it would be desirable to obtain further information as to what are the injuries caused by it, when it appears, and where it hibernates. It is common throughout the province.

LOHITA GRANDIS, *Gray*.

Lygaeus grandis, Gray in Griff. An. King, Ins. ii, p. 242, t. 92, f. 3 (1832).

Astemma grandis, Brullé, Hist. Ins. ix, p. 383 (1836).

Macroceroea longicornis, Spinola, Ess., p. 177 (1837).

Macroceraia grandis, Guérin, Icon. Regne An. Ins., p. 346, t. 56, f. 3 (1838).

Lohita grandis, Am. and Serv., Hist. Nat. Ins. Hém., p. 266 (1843); Stål., En. Hem. i, p. 98 (1870); Ofvers., K. V.-A. Förh, p. 664 (1870); Walker, Cat. Het. v, p. 167 (1872); Distant, J. A. S. B. xlviii (2), p. 37 (1879); A. M. N. H. (5 s.) iii, p. 127 (1879).

Var. *Lohita longissima*, Stål., En. Hem., i, p. 98 (1870); Walker, Cat. Het., v. p. 167 (1872); Distant, A. M. N. H. (5 s.), iii, p. 127 (1879).

Red: two spots on the hemelytra, antennæ, tibiæ and tarsi, black apex of anterior femora internally dentate (*Gray*).

♂ Red: some brown marks on the pronotum: a broad spot on the corium, the membrane, 2-3 lateral bands on the pectus, a lateral patch on each ventral incisure, the feet (except the first femora and a part of the intermediate, which are red), and the antennæ (except the base of the first joint and the articulations of the other joints) black (*Am. & Serv.*). Rather common in Calcutta, and easily recognised by the abbreviated hemelytra in the ♂. *Long*, 35-45 mill.

Var. ♂. Rufous-testaceous: antennæ, rostrum towards the apex, scutellum, oblong spot on clavus; median spot on corium, membrane, lateral spots on pectus and venter, also the feet (the first femora excepted) black; antennæ very long, first joint almost thrice longer than the head and thorax taken together: abdomen extended by half behind the hemelytra (*L. longissima*, Stål). Differs from *L. grandis*, Gray, only in the much longer antennæ and abdomen. *Long*, 50; broad, 8 mill.

Reported from India, Bengal, Assam.

A single specimen of the species known as *Physopelta schlanbuschii*, Fabricius, occurred with others in a bottle sent from Kushtea and labelled

Kuti-poka, insects that affect the rice-crop: further information is required in regard to this also.

Physopelta Schlanbuschii, *Fabricius.*

Cimex Slanbuschii, Fabr., Mant. Ins. ii, p. 299 (1787); Gmelin Ed. Syst. Nat., i (4), p. 2172 (1788): Stål., Punaises, p. 151, t. 38, f. 273 (1788).

Lygæus Slanbuschii, Fabr., Ent. Syst. iv, p. 155 (1794).

Lygæus Schlanbuschii, Fabr., Syst. Rhyng., p. 222 (1803).

Pyrrhocoris Schlangenbuschii, Burm., Handb. Ent. ii (i), p. 286 (1835).

Physopelta Schlanbuschii, Stål, Ofvers. K. V.-A., Förh., p. 195 (1861); Berlin Ent. Zeitschr. vii, p. 391 (1863); Hem., Fabr. i, p. 80 (1868); En. Hem. i. p. 100 (1870); Walker, Cat. Het. vi, p. 20 (1873) var.: Distant; A. M. N. H. (5 s.) iii, p. 127 (1879).

Sanguineous: antennæ dull black, last joint cinereous: head immaculate: thorax with a broad deep black band not reaching the margins: scutellum deep black: hemelytra smooth, with a black round spot in the middle; wings black, immaculate: beneath also sanguineous with abbreviated dull black bands: feet fuscous; femora sanguineous (*Fabr.*); antennæ, tibiæ and tarsi, fuscous: pronotum with two spots, scutellum, a large spot on the corium and the membrane, black (*Burm.*): one or two interrupted bands and the thorax forming four transverse quadrate spots, two anterior and two posterior occur in specimens from Calcutta and Assam respectively. *Long,* 16½ mill.

Reported from China, Assam, and Calcutta (Ind. Mus.).

In 1884 Mr. J. Cleghorn forwarded a pentatomid, which was stated to have attacked and destroyed the caterpillars of Tusser silk-worms feeding in the open. This rather strange habit requires verification, and should be carefully observed. The insect is large enough to be readily picked off by the hand, and can hardly occur in sufficient numbers to become formidable. It belongs to the *Rhynchota,* family *Pentatomidæ,* and was first described by Wolff in 1801.

Canthecona furcellata, Wolff.

[*Plate VI, Fig. 3; nat. size.*]

Atkinson, Journ. As. Soc. Beng., lvii (2), 1888, p. 175.

Antennæ 5-jointed, ferruginous-yellow, joints fuscous at the apex: head porrect, obtuse, impressly punctured, varied fuscous and tawny, with a paler longitudinal line: eyes fuscous: rostrum 4-jointed, ferruginous, fuscous at the apex: pronotum greyish, anteriorly varied fuscous, posteriorly with numerous impressed fuscous dots or points, the anterior

longitudinal line tawny-yellow; lateral margin serrulate, armed posteriorly on both sides with a fuscous, bifid spine, and behind it with a short tooth: scutellum greyish, with several impressed fuscous dots at the base with three rather obscure, minute, rufous dots; longitudinal line and apex, paler: hemelytra greyish, with impressed fuscous dots, and a median, obsolete, fuscous band; membrane fuscous, with two pale, opposite, marginal spots before the apex: abdomen above black, spotted yellow on the margin, which is somewhat prominulous; beneath testaceous, with a row on both sides, of very minute fuscous dots; margin subserrate; sternum somewhat porrect anteriorly: pectus testaceous, spotted fuscous: anus obtusely bidentate: feet testaceous; first femora with a very acute tooth before the apex: tarsi fuscous. Varies in the markings on the hemelytra. *Hab.*—India, Burma. *Long*, 15-16 mill.

The bottles sent from Cawnpore contain two species of Rhynchota, one of Orthoptera, and the larvæ of several other insects, probably moths.

Amongst the Rhynchota I find:—

Dysdercus cingulatus.

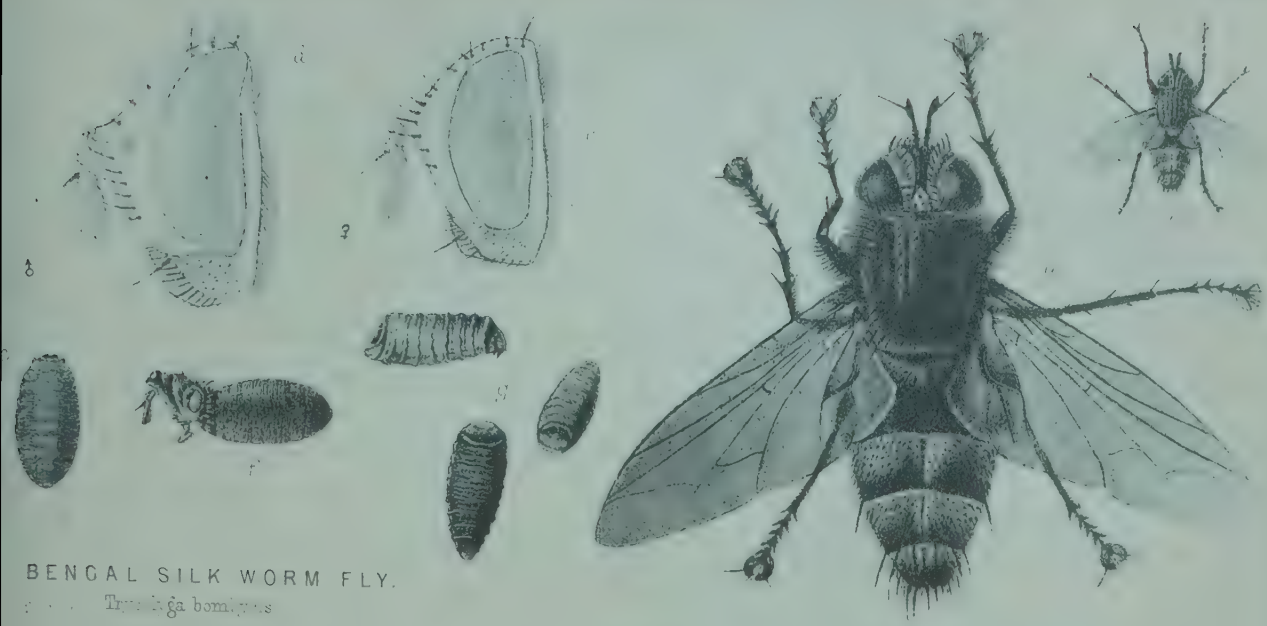
Fabricius, Syst. Ent., 1775, p. 719.

This insect, easily recognised by its vermillion colour, white transverse bands on the abdomen, and a black spot in the middle of each hemelytron, occurs throughout the whole oriental region, extending as far as New Guinea, Philippines, China. It does not do much harm unless occurring in excessive numbers.

Apines concinna.

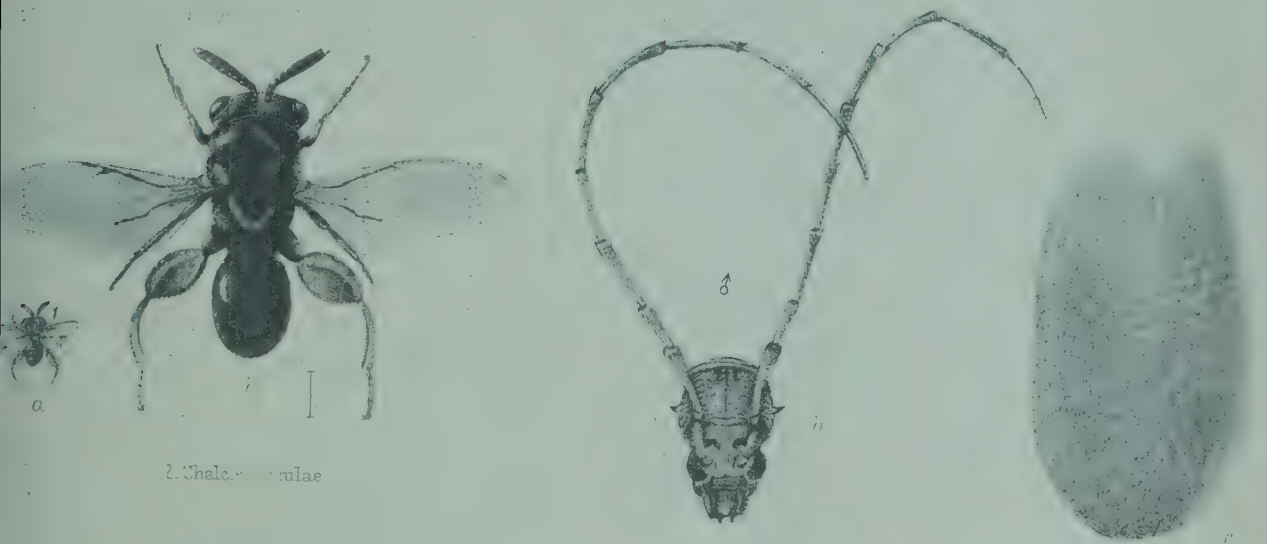
Dallas, List Hem., i, p. 232, t. 9, f. 1: Atkinson, Journ. As. Soc. Beng., lvii (2), 1888, p. 139.

I have already obtained this insect from Bombay and Hardwar (N.-W. Provinces). The series before me shows that *A. concinna* varies much in size, from 5 to 6 mill., and in color above from black to brown, with the white markings more or less patched with orange, and the abdomen beneath from sordid white to brown. The larval state is well represented, but some further particulars regarding the manner in which the insect attacks the *rabi* crops are necessary before any useful deductions can be obtained from its presence, apparently in considerable numbers. In its habits it cannot differ much from *Murgantia histrionica*, a well-known garden and field pest in America, the methods for combating which are detailed in the reports of the Washington Department of Agriculture.

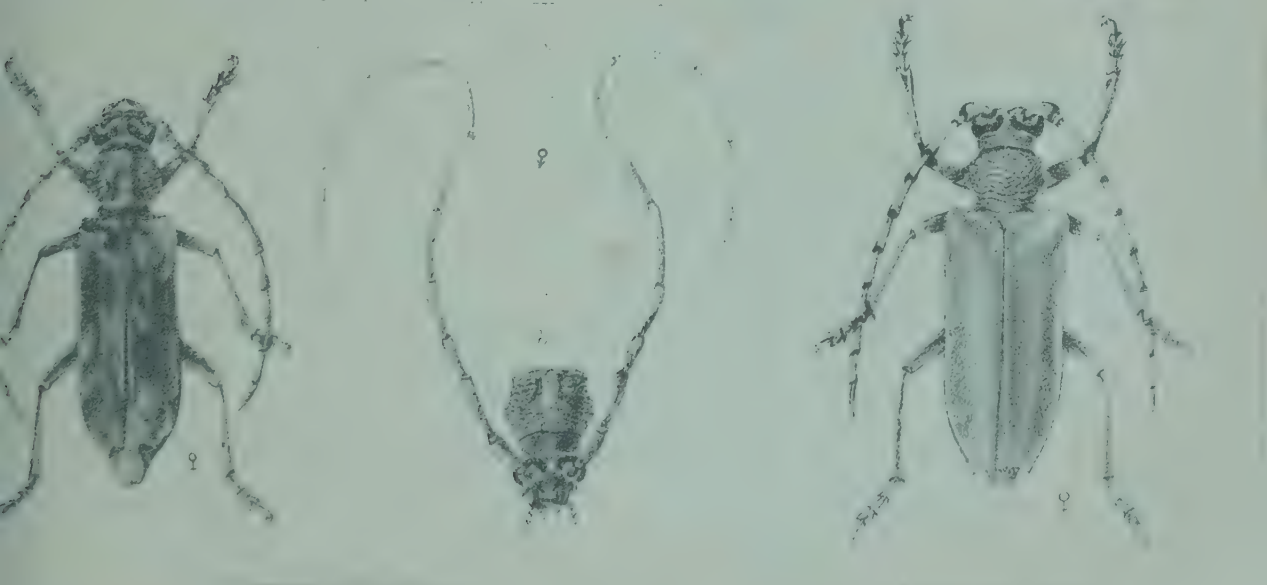


BENGAL SILK WORM FLY.

Tr[illegible]ga bom[illegible]s

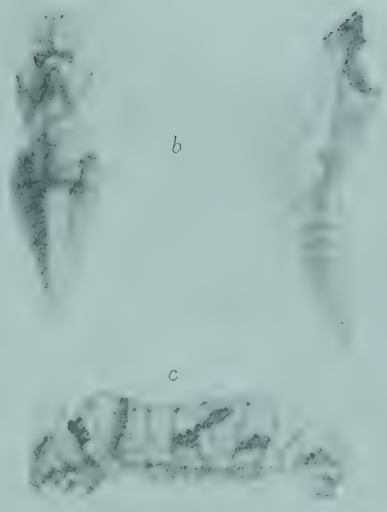


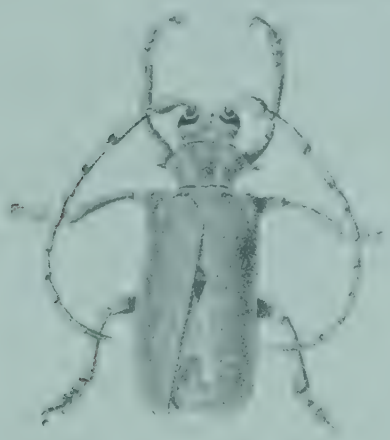
2. Chalc[illegible]ulae



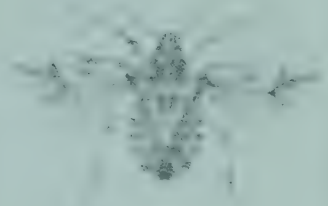
1. Clocederus pedestr[illegible]

1 Papilio erithonius





2. SAL GIRDER.



3. Canthecona Furcellata

4 Heliothis armigera

Aulacophora abdominalis.

6. Cecidomyia oryzae.

Chackraborty & B L Dos del.

Photo etching from the original pencil Drawings Survey of India Offices, Calcutta, September 18

2. Lecanium coffeae

3. Lecanium viride

Litho., S. I. O., Calcutta

NOTICE.

THE serial *Indian Museum Notes* is issued by the Trustees of the Indian Museum, Calcutta, under the authority of the Government of India, Revenue and Agricultural Department. It is chiefly intended to record information on the subject of Economic Entomology, and thus gradually to furnish the materials upon which to base a comprehensive knowledge of this important subject, which has hitherto been but little studied in India. For the views expressed the authors of the respective *Notes* are alone responsible.

The parts of the serial will be published from time to time as materials accumulate. Communications are invited; they should be written on one side only of the paper and addressed to—

The Editor,

"*Indian Museum Notes*,"

Calcutta.

Correspondence connected with Economic Entomology should be accompanied by specimens of the insects to which reference is made. Caterpillars, grubs and other soft-bodied insects can be sent in alcohol; chrysalids and cocoons, alive, and packed lightly in leaves or grass; other insects, dried and pinned or wrapped in soft paper. Live insects should be sent when there is a reasonable probability of their surviving the journey. Caterpillars, grubs, and other immature insects can often be only approximately determined; they should therefore, where possible, be accompanied by specimens of the mature insects into which they transform. When, however, this is not possible, they should still be sent, as they can always be determined approximately, and uncertainty must necessarily arise in discussing insects when actual reference to the specimens cannot be made. Insects that are forwarded for identification should in all cases be accompanied by a detailed account showing precisely in what their economic importance consists.

INDIAN MUSEUM;

CALCUTTA: THE EDITOR.

November 1889.

SILKWORMS IN INDIA,

BY

E. C. COTES.

PREFACE.

THIS paper is intended to show concisely what is known of the natural history and methods adopted in rearing the silk insects actually cultivated in India for the production of silk; these forming an important section of the economic insects whose investigation has been entrusted to the writer. It is chiefly founded upon the materials which were brought together in 1888, when collections illustrative of Indian sericulture were prepared, under the direction of the Trustees of the Indian Museum, for distribution by the Government of India to scientific institutions in India and Europe. These materials showed that it is now possible to furnish a fairly complete account of the subject, and this paper must therefore be looked upon as little more than an attempt to collect into a convenient form what has hitherto been scattered through a number of reports.

It was at first intended that the account should include what is known of the natural history of all the silk-producing insects, belonging to the Lepidopterous families of Bombycidæ and Saturniidæ, that are found in India, and with this end in view a considerable amount of material was collected. Press of other work has prevented the whole of this programme from being carried out, and as more than a year has already elapsed since it was commenced, it appears best to confine the paper to those species which are actually utilized in India for the production of silk, and which are therefore the only ones which can be looked upon as of any real economic importance.

The purely commercial side of the silk question, connected, as it is, with the conditions of silk markets, and the rise and fall of prices in all parts of the world, is of such magnitude that it would obviously be out of place to attempt to discuss it here. It has been very fully dealt with by Geoghegan in his *Account of Silk in India*, Calcutta, 1872, by Liotard

in his *Memorandum on Silk in India,* Calcutta, 1883, and by Rondot in his general work *L'Art de la Soie,* Paris, 1885-87. It may be noticed, in passing, however, that the general features it presents are a sustained depression in the silk trade, especially in that portion of it connected with reeled silk, together with a general tendency to devote attention to carded silk, and to the rough silk produced by the semi-domesticated silkworms of India and China.

DOMESTICATED MULBERRY SILKWORMS.

[Plate VIII, *b* and *c*, and Plate IX.]

The classification of the domesticated mulberry-feeding silkworms, which are reared in different parts of the world, has long been a puzzle to entomologists; the fact being that, while the extreme forms of each variety are well marked and distinct, both in habits and appearance, they are connected by so many intermediate forms that in most cases it is impossible to fix any line of demarcation which shall separate the varieties into groups having distinct characteristics; added to this, so far as has at present been observed, even the most distinct forms are subject to the same diseases, and interbreed readily, when allowed to do so, producing fertile offspring which present characteristics intermediate between those of their parents. On the whole, therefore, it seems best to look upon all domesticated mulberry-feeding silkworms as belonging to the one species *Bombyx mori,* the innumerable varieties being considered as merely Sub-species or races, though for convenience we may retain their old nomenclature, which accords them the rank of Species. Of these races, or sub-species, we may notice the common annual silkworm (*Bombyx mori*) which is reared in Japan, Central Asia, Southern Europe, and indeed throughout the whole of the temperate zone. It comprises innumerable local varieties which agree, more or less absolutely, in being *univoltine* (that is to say, in going through but one generation in the course of the year); in the cocoons being of a firm and close consistency, so that the silk can be readily reeled off them; and in the eggs requiring to be exposed to a certain degree of cold to enable them to hatch out regularly and healthily. Connected with this race are bivoltine[1] varieties, which produce two crops in the course of the year, the eggs of the second generation only being kept for the next year's crop, as those of the first

[1] Rondot, in his *L'Art de la Soie* writes that the Genoese were the first to introduce the bivoltine worms of China into Europe. The cocoons, which are white in colour, were reared at Novi Ligure with the greatest care and gave good results, the silk becoming well known under the name of "*candide di novi.*"

generation hatch soon after being laid; also trevoltines[1], which pass through three generations in the year, and *quadrivoltines*[2], which pass through four. There is an annual, or *univoltine* silkworm, *Bombyx textor*, known in Bengal as the *Boro polo*, which produces cocoons of loose texture, which are therefore more difficult to reel than the firm cocoons made by the univoltine silkworms of the temperate zone. But the most important varieties in India are the *Desi* (*Bombyx fortunatus*), *Madrassi* (*Bombyx croesi*), *Chota pat* (*Bombyx sinensis*), and *Nya paw* (*Bombyx arracanensis*), all four of which pass through a succession of generations, sometimes amounting to as many as eight, in the course of the year, the eggs hatching out healthily without exposure to cold, and the cocoons containing comparatively little silk, and that so loosely wound upon the cocoon as to be difficult to reel off without entanglement. It is these small *multivoltines* which yield the bulk of the silk produced in India; but three,[3] or at most four, of the generations produced in the year being raised in sufficient numbers to yield cocoons for the production of silk, and the intermediate generations being only reared in comparatively small quantities by men who devote themselves to the work of raising *seed* (eggs) from which the regular cocoon crops, or *bunds*, are reared.

Neglecting varieties which are not reared in large quantities, we may say that the general silk crop of Europe is produced by a variety of silkworm which thrives in a temperate climate, requires cold for the hatching of its eggs, and produces but one crop of cocoons in the year, these cocoons, however, containing a large amount of silk which can be easily reeled. In India, on the contrary, the general silk crop is produced by smaller varieties, which thrive in sub-tropical climate, do not require cold for the hatching of their eggs, and produce each year a series of crops of cocoons which contain, comparatively, a small amount of silk, itself perhaps equal in quality to that produced by the European variety, but so loosely wound upon the cocoon that it is almost impossible, in reeling it off, to prevent entanglement and thus to produce a thread equal in value to that easily obtained from the European variety.

In the steamy plains of Bengal, where the silk industry is chiefly carried on, the mulberry will yield several crops of leaves in the year. A *multivoltine* silkworm, therefore, which can be raised several times in the course of the year, suits the requirements of the country. The

[1] Rondot, *l. c.*, writes that there is a constant variety of *trevoltine* silkworms to be found at Pistoria and other places in Tuscany.

[2] Riley: U. S. Department of Agriculture Bull. No. 9.

[3] In Bengal, where most of the silk-rearing is done, the regular crops or *bunds* are known as the November *bund*, the March *bund*, and the July *bund*; a fourth *bund* being only attempted on a small scale, after the close of the July *bund*, by such rearers as happen to have leaf to spare; the fourth bund therefore is of but little importance.

superiority, however, of the cocoons of the European variety is so obvious that many attempts have been made to introduce this form into India, or to cultivate a cross between it and the native races. Except, however, in Kashmir, which has an almost European climate, and upon a small scale in Dehra Dun and the Punjab, where the eggs are sent up into the Himalayas annually for the necessary cold, the introduction of the European variety has not been successful; while crosses between it and the *multivoltine* varieties, though at first often producing cocoons superior to *multivoltine* ones, rapidly deteriorate, and are considered unsatisfactory[1]. It is possible that a further attempt will be made to introduce the European variety into Bengal, special arrangements being made for cooling the eggs before the hatching, which it is anticipated can be arranged to take place at two different times in the year, so as to give two crops, as has already been done in Italy[2]. It remains, however, to be seen to what extent this attempt will prove successful.

Silkworms can be raised upon all kinds of mulberry. For adoption in India Duthie recommends the variety *Morus multicaulis* as most

[1] See Bashford's Experiments (Geoghegan's *Account of Silk in India;* 1872, p. 21) in crossing French, Italian, and China annuals with *Madrassi* and *Desi* multivoltines. The results, though promising at first, were not considered satisfactory, as the stock rapidly deteriorated and generally reverted to inferior annuals. See also an account of a similar experiment carried out in the Indian Museum (*Indian Museum Notes*, Vol. I, No. 2, p. 123).

[2] Rondot, in his *L'Art de la Soie*, writes that Duseigneur mentions two rearings made in one year near to Sorrente in the province of Naples. The eggs belonged to an annual variety and were preserved in some cold caves. One part, put to hatch at the usual time, gave the first crop; the rest remaining subject to the cold, and put to hatch later on gave a second crop which was smaller than the first.

The conditions which regulate the hatching of eggs of the annual variety are as follows, according to Du Claux (see Mukharji's Notes, published by the Government of Bengal, 1888):

When the eggs are first laid they breathe with activity, the oxidization causing them to change in colour from yellow to purple. At this stage the forced suspension of vitality by the application of cold is hurtful, but after a period of three weeks or a month, the eggs enter into a state of rest, and can then be subjected without harm to the cold which is necessary for starting the further development of the embryo. The temperature required for this refrigeration is about 32° to 40° Fahrenheit. In the case of eggs refrigerated soon after being laid, a two months' sojourn in the refrigerator is necessary; a shorter period, however, sufficing for eggs that are already several months old when subjected to the action of cold. After coming out of the refrigerator a period of six weeks or two months of a low but gradually rising temperature is required for the healthy development of the eggs, before they are hatched out by the action of a temperature of about 75° Fahrenheit. When once the eggs have been refrigerated the development of the embryo proceeds regularly, and any attempt to retard the hatching is deleterious: the time passed in the egg stage can therefore be increased or diminished only by increasing or diminishing the period that elapses before refrigeration. Du Claux succeeded in getting eggs to hatch out healthily within about 145 days of being laid, instead of the usual ten months; this he did by taking eggs about 20 days old and exposing them to the action of cold for two months, and then to a low but gradually rising temperature for six weeks; at the end of

suitable; in Bengal *Morus indica* is the mulberry generally used for silk-rearing[1].

The mulberry silkworms of the temperate zone have long been known to suffer from a number of diseases. These were studied exhaustively by Pasteur, between the years 1865 and 1870, and the remedial measures which he recommended have since been widely adopted in Europe, where they have proved the salvation of the silk industry. In Bengal, mulberry silkworms suffer from similar diseases, which have been found by Wood-Mason and Mukharji to be identical with the diseases known in Europe. Within the last few years accordingly experiments have been carried on in Berhampore, with the support of the Government, with a view to introducing Pasteur's system into India. Baboo Mukharji, who conducted the investigation, has found some practical difficulties in the way of applying, to the multivoltine insects of Bengal, the remedies that were devised for the univoltine silk-worms of Europe; there would seem however to be considerable reason to hope that Pasteur's methods may ultimately be adapted to the requirements of the Bengal silk industry.

A detailed account of the chief diseases to which domesticated mulberry silkworms are subject is given in the special part of this paper which deals with *Bombyx mori* proper, p. 142. The following is a summary :—

a. Pebrine[2], which is known in Bengal as *kata*, or, when in an aggravated form, as *tali*, is characterized by the presence of microscopic corpuscles[3] of oval shape which are found in the tissues of the silk-worm, and also in the pupa, moth and eggs. The disease is not always fatal, but when it does not kill the worm it damages the quality of the

which time they hatched out healthily when incubated by increasing the temperature. 145 days he considers to be about the minimum time required for the healthy hatching of eggs. He observes that the hatching can be retarded, so as to make the eggs take up to twenty months in producing caterpillars, by keeping them at a uniform temperature of about 60° to 70° Fahrenheit, from the time they are laid through a series of months, after which they can be hatched out healthily by refrigeration and gradual warming as before; about three months in all being taken up by these processes.

[1] See Notes by Duthie and Blechynden in the Journ., Agri.-Horti. Soc., Vol. VI (1878 to 1881).

[2] Mukharji reported in January 1888 that, while *Flacherie*, *Grasserie*, and *Muscardine* have always been known in Bengal, *Pebrine* has only appeared within the last ten or twelve years, becoming each year more destructive, and causing fears of a total collapse of the silk trade.

[3] These are the corpuscles of *Panhistophyton ovatum* (*Nosema bombycis*, *Micrococcus ovatus*, *corpuscles du ver à soie*), shining oval cocci 2—3 μ. long, 2 μ. wide, occurring singly and in pairs, or masses, or in rods 2·5 μ. thick and 5 μ. long. They multiply by subdivision. They have been experimentally proved to be the cause of *pebrine*, *gattine*, *maladie des corpuscles*, or *flecksucht*; and are found in the organs of diseased silkworms, as well as in the pupæ, moths and eggs.—(Crookshank's *Introduction to Practical Bacteriology*; London, 1886).

cocoon. Besides being contagious, the spores preserving their power of communicating the disease for considerable periods, it is also hereditary, the eggs laid by a pebrinized female tending to produce pebrinized worms. The remedy therefore consists in general sanitary precautions to prevent infection, and in breeding only from eggs laid by such females as are found on microscopical examination, after they have laid their eggs, to be free from corpuscles; the eggs laid by moths which prove to be pebrinized being carefully rejected.

b. Flacherie, which is known in Bengal as *kala shira*, is characterized by the presence of a chain ferment[1] in the digestive tract of the silkworm and pupa; the disease is contagious, and to a certain extent hereditary in that the larvæ of moths which show symptoms of flacherie have a predisposition to take the disease. The remedy therefore consists in general sanitary precautions to prevent infection, and in the rejection, for breeding purposes, of all eggs obtained from batches of cocoons, which, on microscopical examination of the digestive tracts in a percentage of the pupæ, show signs of the chain ferment.

c. Muscardine, which is known in Bengal as *chuna*, is caused by a fungus, *Botrytis bassiana*, which appears as a white efflorescence on the body of the worm some hours after it has died of the disease. The disease is contagious, but not hereditary, for, though the worm may be so slightly affected that it is able to spin, it invariably dies before it becomes a moth, while healthy pupæ, being protected by their cocoons, are not liable to be affected. The disease is spread by the spores, which only appear several hours after the death of the diseased worm; in the speedy removal therefore of all dead worms from the breeding trays, is found an efficient preventive.

d. Grasserie, which is probably the same as the disease that is known in Bengal as *rasa*, is of but little importance, and is never hereditary. Little seems to be known about it.

Besides being subject to the above diseases, silkworms suffer from the attacks of various parasitic and other enemies. In Bengal considerable loss is occasioned by the Tachinid fly[2] *Trycolyga bombycis*, which lays its eggs upon the body of the worm. Its grubs, on emerging from the eggs, bore into the tissues of the worm, and remain there until they are full grown; they then cut their way out and betake themselves to the ground, where they pupate. When attacked by this pest the

[1] This ferment is *Streptococcus bombycis* of Bechamp (*Microzyma bombycis*); oval cocci, ·5 μ. in diameter, occurring singly or in pairs or chains. They are found in the contents of the alimentary canal, and in the gastric juice of silkworms suffering from *flacherie* (*maladie de morts blanc*, *flaccidezza*, or *schlaffsucht*).—(Crookshank's *Introduction to Practical Bacteriology*; London, 1886.)

[2] For a detailed account of this pest see *Indian Museum Notes*, Vol. I, No. 2.

caterpillar generally continues to live and feed as before, and in some cases spins a cocoon, but it invariably perishes when the grubs cut their way out. The cocoon made by a parasitised worm is generally a poor one to begin with, and is rendered unfit for reeling by the hole made by the grub in escaping from it. This pest can be to a great extent kept under by the removal of all rubbish in which the grubs pupate, the speedy suffocation of all cocoons that are known to harbour fly, the establishment of well-marked intervals of time between the bunds, so that the flies that are bred with the worms of one bund die out before the next bund commences, and by precautions to prevent the propagation of the fly in the intermediate generations of silkworms that are reared for the production of seed. A somewhat similar parasite attacks the mulberry silkworms of China[1], while in Japan the *oudji* fly[2] (*Udschymia sericaria*), which however has a somewhat different life history, affects silkworms much in the same way. Some loss is also occasioned in silk-rearing establishments by rats, mice and ants, also by *Dermestes* and *Anthrenus* beetles, particularly by *Dermestes vulpinus*[3], which penetrates the cocoons, and thus renders them unfit for reeling. The damage however that is done by these pests is generally of only secondary importance.

BOMBYX MORI.[4]

[Plate VIII (*b*) and Plate XV.]

This is the common annual silkworm domesticated in Japan, China, Bokhara, Afghanistan, Kashmir, Persia, South Russia, Turkey, Egypt, Algeria, Italy, France, Spain, America, and Australia. It requires cold for the uniform hatching of its eggs, and produces a close-grained cocoon containing a large amount of silk, of a golden yellow or white colour, that can readily be reeled. This silkworm is essentially suited to the conditions of a temperate climate, and is not generally cultivated in India, though it has been grown on a small scale in Dehra Dun (North-Western Provinces), and also in some parts of the Punjab. In Dehra Dun (2,300 feet above sea-level) the eggs are hatched in February, and the cocoons are ready by the end of March. The eggs

[1] Rondot: *L'Art de la Soie*, Vol. II, p. 486.

[2] Sasaki's paper in Journal of College of Science, Tokio, Japan, I (1), 1886.

[3] See *Indian Museum Notes*, Vol. I, No. I, p. 47 (1889).

[4] *Phalaena Mori*, Linn.: Syst. Nat. ii, p. 817 (1767).
Bombyx Mori, Fabr.: Sp. Ins. ii, p. 180 (1781).
„ Pasteur: *Etudes sur la Maladie des Vers à Soie* (1870).
„ Maillot: *Leçons sur les Vers à Soie du Murier* (1885).
„ Rondot: *L'Art de la Soie* (1885-87).
„ Riley: U. S. Dep. Agric. Div. Ent. Bull. No. 9 (1886).

which are retained as seed for the next year's crop are then sent up to Mussoorie (7,400 feet above sea-level), where the comparatively low temperature prevents their hatching out until brought down again to Dehra in the February of the following year.[1]

The following general account of the cultivation of *Bombyx mori* in a temperate climate is taken from Riley's Manual, U. S. Dept. Agric., Bull. No. 9 (1886)[2]:—

"*The egg.*—The egg of the silkworm moth is called by silk-raisers the *seed*. It is nearly round, slightly flattened, and in size resembles a turnip seed. Its colour, when fresh deposited, is yellow, and this colour it retains if unimpregnated. If impregnated, however, it soon acquires a gray, slate, lilac, violet, or even dark green hue, according to variety or breed. It also becomes indented: when diseased, it assumes a still darker and dull tint. Near one end a small spot may be observed; this is the *micropyle*, and is the opening through which the fecundating liquid is injected just before the egg is deposited by the female. After fecundation, and before deposition, the egg of some varieties is covered with a gummy varnish, which closes the *micropyle* and serves to stick the egg to the object upon which it is laid. Other varieties, however, ... have not this natural gum. As the hatching point approaches, the egg becomes lighter in colour, which is due to the fact that its fluid contents become concentrated, as it were, into the central forming worm, leaving an intervening space between it and the shell, which is semi-transparent. Just before hatching, the worm within becomes more active; a slight clicking sound is frequently heard, which sound is, however, common to the eggs of many other insects. The shell becomes quite white after the worm has made its exit, by gnawing a hole through it, which it does at the micropyle. Each female produces on an average from three to four hundred eggs. In the standard ounce of 25 grams ($28\frac{1}{3}$ grams = 1 oz. avoirdupois) there are about 50,000 eggs in the small Japanese races, 37,500 in the ordinary yellow annual varieties, and from 30,000 to 35,000 in the races with large cocoons. The specific gravity of the egg is slightly greater than water . . . . It has been noticed that the colour of the albuminous fluid of the egg corresponds to that of the cocoons, so that when the fluid is white the cocoon produced is also white, and when yellow the cocoon again corresponds . . . .

"*The larva or worm.*—The worm goes through from three[3] to four molts, or *sicknesses*, the latter being the normal number. The periods between these different molts are called *ages*, there being five of these *ages*, the first extending from the time of hatching to the end of the first molt, and the last from the end of the fourth molt to the transformation of the insect into a chrysalis . . . . The time from the hatching to the spinning of the cocoons may, and does, vary all the way from thirty to forty days, depending upon the race of the worm, the quality of food, mode of feeding, temperature, &c. . . . . The colour of the newly hatched worm is black or dark-gray, and it is covered with long stiff hairs, which, upon close examination, will be found to spring from pale-coloured tubercles. Different shades of dark-gray will however be found amongst worms hatching from the same batch of eggs. After the

[1] From Fuller's account of a sericultural experiment in Chindwara (1883).

[2] This work is based upon the writings of Pasteur and Maillot.

[3] In his *L'Art de la Soie*, Rondot writes that a constant variety of worms with three molts is found in Milan. Both worms and cocoons are small and the cultivation of the race is but little extended in either France or Italy.

first molt, and as the worm increases in size, these hairs and tubercles become less noticeable, and the worm generally gets lighter and lighter, until in the last stage it is of a cream white colour. It never becomes entirely smooth, however, as there are short hairs along the sides, and very minute ones, not noticeable with the unaided eye, all over the body. The preparation for each molt requires from two to three days of fasting and rest, during which time the worm attaches itself firmly by the abdominal prolegs (the eight non-articulated legs under the 6th, 7th, 8th and 9th segments of the body, called prolegs in contradistinction to the six articulated true legs under the 1st, 2nd, and 3rd segments) and holds up the fore part of the body, and sometimes the tail. In front of the first joint a dark triangular spot is at this time noticeable, indicating the growth of the new head; and when the term of *sickness* is over, the worm casts its old integument, rests a short time to recover strength, and then, freshened, supple and hungry, goes to work, feeding voraciously to compensate for lost time. This so-called *sickness*, which preceded the molt, was in its turn preceded by a most voracious appetite, which served to stretch the skin. In the operation of molting the new head is first disengaged from the old skin, which is then gradually worked back from segment to segment until entirely cast off. If the worm is feeble, or has met with any misfortune, the shrivelled skin may remain on the end of the body, being held by the anal horn; in which case the individual usually perishes in the course of time. It has been usually estimated that the worm in its growth consumes its own weight of leaves every day it feeds; but this is only an approximation. Yet it is certain that during the last few days before commencing to spin it consumes more than during the whole of its previous existence. . . . . Having attained its full growth, the worm is ready to spin up. It shrinks somewhat in size, voids most of the excrement remaining in the alimentary canal, acquires a clear, translucent, often pinkish or amber hue, becomes restless, ceases to feed, and throws out silken threads. The silk is elaborated in a fluid condition in two long, slender, convoluted vessels, one upon each side of the alimentary canal; as these vessels approach the head they become less convoluted and more slender, and finally unite within the spinnaret, from which the silk issues in a glutinous state and apparently in a single thread. The glutinous liquid which combines the two threads, and which hardens on exposure to the air, may, however, be softened in warm water. The worm usually consumes from three to five days in the construction of the cocoon, and then passes in three days more by a final molt into the chrysalis state.

"*The cocoon.*—The cocoon consists of an outer lining of loose silk known as *floss*, which is used for carding, and is spun by the worm in first getting its bearings. The amount of this loose silk varies in different breeds. The inner cocoon is tough, strong, and compact, composed of a firm continuous thread, which is . . . . wound . . . . irregularly in short figure-of-eight loops, first in one place and then in another, so that, in reeling, several yards of silk may be taken off without the cocoon turning round. In form the cocoon is usually oval and in colour yellowish, but in both these features it varies greatly, being either pure silvery white, cream, or carneous, green, or even roseate.

"*The chrysalis.*—The chrysalis is a brown, oval body, considerably less in size than the full-grown worm. In the external integument may be traced folds corresponding with the abdominal rings, the wings folded over the breast, the antennæ, and the eyes of the inclosed insect—the future moth. At the posterior end of the chrysalis, pushed closely up to the wall of the cocoon, is the last larval skin, compressed into a dry wad of wrinkled integument. The chrysalis state continues for from two to three weeks, when the skin bursts and the moth emerges.

"*The moth.*—With no jaws, and confined within the narrow space of the cocoon, the moth finds some difficulty in escaping. For this purpose it is provided, in two glands near the obsolete mouth, with a strongly alkaline liquid secretion, with which it moistens the end of the cocoon and dissolves the hard gummy lining.[1] Then by a forward and backward motion, the prisoner, with crimped and damp wings, gradually forces its way out; and the exit once effected, the wings soon expand and dry. The silken threads are simply pushed aside, but enough of them get broken in the process to render the cocoons from which the moths escape comparatively useless for reeling. The moth is of cream colour, with more or less distinct brownish markings across the wings. The males have broader antennæ than the females, and may be by this feature at once distinguished. Neither sex flies, but the male is more active than the female, and may be easily recognized by a constant fluttering motion of the wings, as well as the feature mentioned above. They couple soon after issuing, remaining coupled during several hours, and in a short time after separation the female begins depositing her eggs.

"*Hatching.*—Under natural conditions the egg undergoes a partial development as soon as laid, as shown by its changing colour. After oviposition, and until subjected to cold, the eggs of the annual races are not capable of hatching out. This is the rule, although we often find in a batch of annual eggs a few accidental *bivoltines* that hatch some fifteen days after they are laid. The number, however, is very slight, and it has been determined that the temperature to which they are submitted in no way alters the result. During this period, which we call *prehibernal*, the eggs may be kept at any ordinary temperature, however warm, but once they are submitted to the cold of winter a certain change takes place in them, the nature of which has not yet been determined, and their subsequent warming may then result in hatching . . When kept at a uniform low temperature, after having once been cooled, development is imperceptible, and when afterwards exposed to the proper hatching conditions, the resultant worms hatch out healthily. If possible, the temperature should never be allowed to rise above 40° Fahrenheit, but may be allowed to sink below freezing point without injury. Indeed eggs sent from one country to another are usually packed in ice.[2] A great object should be to have them hatch uniformly, and this is best attained by keeping together those laid at one and the same time, and by wintering them, in cellars or hybernating boxes that are cool enough to prevent any embryonic development. They should then, as soon as the leaves of their food plant have commenced to put forth, be placed in trays and brought into a well aired room, where the temperature averages about 75° Fahrenheit. If they have been wintered adhering to the cloth on which they were laid, all that it is necessary to do is to spread this same cloth over the bottom of the tray. It, on the contrary, they have been wintered in the loose condition, they must be uniformly sifted or spread over sheets of cloth or paper. The temperature should be kept uniform, and a small stove in the hatching room will prove very valuable in providing this uniformity. The heat of the room may be increased about 2° each day, and if the eggs have been well kept back during the winter, they will begin to hatch under such treatment on the fifth or sixth day. By no means must the eggs be exposed to the sun's rays, which would kill them in a very short time. As the time of hatching approaches, the eggs grow lighter in colour, and then, if the weather be dry, the atmosphere must be kept moist artificially by sprinkling

[1] The Tusser moth is thought to secrete this solvent fluid in the alimentary tract, see p. 158.

[2] For a further account of the conditions which regulate hatching see foot-note to p. 132.

the floor, or otherwise, in order to enable the worms to eat through the egg-shell more easily. They also appear fresher and more vigorous with due amount of moisture. It will be found that eggs which have been subjected to a great cold during the winter will require a longer time in their incubation than those which have been kept at a higher temperature, and it is also true, as has been intimated above, that when the atmosphere in which the eggs have been retained has been excessively dry, it will require considerable humidity to cause them to hatch. Such matters must be largely regulated by the experience of the individual raiser.

"*Rearing.*—The room in which the rearing is to be done should be so arranged that it can be thoroughly and easily ventilated and warmed, if desirable. . . . If but few worms are to be reared all the operations can be performed in trays upon tables, but in large establishments the room should be arranged with deep and numerous shelves, ranging one above another from floor to ceiling. The width of these shelves should not exceed five feet, as those in charge must be able to reach from either side to the middle of each table. Bearing this in mind, the dimensions of these tables may be made to suit the room in which the worms are reared. The vertical distance between two shelves should not be less than twenty inches, but if this space is greatly increased it will be found inconvenient to obtain brush of sufficient length to form the arches upon which the cocoons are to be spun. . . . The chief conditions of success in silk-raising are, the use of good eggs, and the proper care of the worms. The means of obtaining pure eggs will be described hereafter, and we will here consider the second of the conditions. Unless new, and especially when the worms raised with them the preceding season have suffered from any disease, all the implements and furniture used should be cleansed and purified by carefully scrubbing in soap and water. The walls of the room may, where convenient, be submitted to the same operation, and covered with a strong coat of whitewash. The room should then be tightly closed and thoroughly fumigated with burning brimstone during an entire day and night. It may then, after being well aired, be used for the rearing of silkworms. The eggs, when about to hatch, should be spread out on clean paper in as thin layers as possible. Over them should be lightly laid small pieces of ordinary mosquito netting. When the worms begin to appear there should be sparsely scattered over this netting a few buds or finely cut leaves. The newly born larvæ will at once pass through its meshes in search of food, and the whole can then be easily removed to the table upon which they are to pass their first age. It is recommended by many to feed the worms while in this age with leaves that have cut up . . . in order to give them more edges to eat upon and to make less work for them. This, however, is hardly necessary with annuals, although it is quite generally practised in France. The food should be renewed whenever the leaves have been devoured, or whenever they have become in the least dry, which, of course, takes place much quicker when young and tender than when mature. . . . The rule should be observed never to give wet or damp leaves to young worms. In case the leaves are picked during a rain they should be thoroughly dried before being fed, and on the approach of a storm it is always well to lay in a stock, which should be kept from heating by occasional stirring. Care should also be taken to spread the leaves evenly, so that all may feed alike.

"As the first molt approaches . . . the worm begins to lose appetite, grows more slimy, and soon the dark spot above the head appears. The larva at this time generally wanders to an unencumbered spot where it may shed its skin in quiet, and often gets hidden and buried under the superimposed leaves . . . Food should then be given more sparingly, and the meals should cease altogether as soon as the forward worms awake. Some will undoubtedly undergo the shedding of the skin much more easily and

quickly than others, but no food should be given to these forward individuals until nearly all have completed the molt. This serves to keep the batch together . . . It is however unnecessary to wait for all, as there will always be some few which remain sick after the great majority have cast their skins. These may be destroyed, as they are usually the most feeble and most inclined to disease : otherwise the batch will grow more and more irregular in their molting, and the diseased worms will contaminate the healthy ones. . . . The importance of keeping each batch together, and of causing the worms to molt simultaneously, cannot be too much insisted upon as a means of saving time. As soon as the great majority have molted they should be copiously fed, as they grow very rapidly after each molt.

"The second and third castings of the skin take place with but little more difficulty than the first, but the fourth is more laborious, and the worms not only take more time in undergoing it, but more often perish in the act. At this molt it is perhaps better to give the more forward individuals a light feed as soon as they have completed the change, inasmuch as it is the last molt, and but little is to be gained by the retardation, whereas it is important to give them all that they will eat, since much of the nutriment given during the last age goes to the elaboration of the silk. As regards the temperature of the rearing room, great care should be taken to avoid all sudden changes from warm to cold, or *vice versâ*. A mean temperature of 75° or 80° Fahrenheit will usually bring the worms to the spinning point in the course of 35 days after hatching, but the rapidity of development depends upon a variety of other causes, such as quality of leaf, race of worm, &c. If it can be prevented, the temperature should not be permitted to rise very much above 80°. The air should be kept pure all of the time, and arrangements should be made to secure a good circulation. Great care should be taken to guard against the incursions of ants and other predaceous insects, . . . and also against rats and mice, which are to be feared almost as much as any other enemy the silkworm has.

"So much depends upon the conditions of development mentioned above that it is impossible to state the exact quantity of food consumed by the silkworm during its life. It will not be far from the truth, however, to place the amount consumed by the issue of an ounce of healthy eggs, which matures in 35 days, at 6½ pounds during the first age, 20 pounds during the second, 65 pounds during the third, 200 pounds during the fourth, and during the fifth and last age 1,250 pounds. This makes a total of between 1,500 and 1,600 pounds. It need hardly he said that the food mentioned must be of the best quality . . . . . .

"Every worm should be free to move easily without incommoding its fellows. We should therefore allow the issue of an ounce of eggs during the first age, from 10 square feet at the beginning to 30 square feet at the end of the age, daily extending the space occupied by them by spreading their food over a greater surface. In the second age they should be spread in the same manner, so as to cover from 50 to 75 square feet, in the third from 100 to 160 square feet, and in the fourth from 200 to 320 square feet. Entering the last age, spread over 430 square feet of surface, they should gradually be extended until they occupy, at the spinning period, 640 square feet. It need hardly be said that when the worms have been decimated by disease the surface occupied by them need not be so extensive.

"In rearing silkworms great care should be observed in not handling them more than is absolutely necessary, and as in cleaning up the litter made by the caterpillars it is necessary to transport them from one table to another, several methods have been adopted; of these the most satisfactory seems to be by means of netting stretched on light frames, which are laid over the worms, and the fresh leaves placed on top; the

worms crawl through the netting on to the fresh leaves, leaving all the litter behind them, which can be cleared away when the frames are lifted off.

"The litter of the worms should be cleared away, before and after each molt, and once about the middle of the third age, ... while after this it should be cleared away nearly every day.

"Summed up, the requisites to successful silkworm raising are: 1st, uniformity of age in the individuals of the same tray, so as to insure their molting simultaneously; 2nd, no intermission in the supply of fresh food, except during the molting periods; 3rd, plenty of room, so that the worms may not too closely crowd each other; 4th, fresh air and as uniform a temperature as possible; 5th, cleanliness. The last three are particularly necessary during the fourth and fifth ages.

"*Spinning.*— With eight or ten days of busy feeding, after the last molt, the worms will begin to lose appetite, shrink in size, become restless, and throw out silk, and the arches for the spinning of the cocoons must now be prepared. These can be made of twigs of different trees, two or three feet long, set up upon the shelves over the worms, and made to interlock in the form of an arch above them, and interlaced with well-dried brush. The feet of each arch should be only about a foot apart.

"The temperature of the room should now be kept above 80°, as the silk does not flow so freely in a cool atmosphere. The worms will immediately mount into the branches and commence to spin their cocoons. They will not all, however, mount at the same time, and those which are more tardy should be fed often, but in small quantities at a time, in order to economize the leaves, as almost every moment some few will quit and mount. There will always be a few which altogether fail to mount and prefer to spin in their trays. It is best, therefore, after the bulk have mounted, to remove the trays and lay brush carefully over them. The fact that the worms already mounted make a final discharge of soft semi-fluid excrement before beginning to spin makes this precaution necessary, as otherwise the cocoons of the lower ones would be badly soiled.

"As the worms begin to spin they should be carefully watched, to guard against two or three of them making what is called a double or treble cocoon, which would be unfit for reeling purposes.

"Eight days from the time the spinning commenced, it will be time to gather the cocoons. The arches should be carefully taken apart, and the spotted or stained cocoons first removed and laid aside. Care should be taken not to stain the clean ones with the black fluids of such worms as may have died and become putrid, for there are always a few of these in every cocoonery. The outer cocoons of loose or floss silk are then removed from the inner cocoons or pods, and the latter sorted according to colour, weight, and firmness of texture; those which best resist pressure indicating that the worm has best accomplished its work. Too much care cannot be taken to remove the soft or imperfect cocoons, as, if mixed with the firm ones, they would be crushed, and soil the others with their contents.

"*Enemies and diseases of the silkworm.*—As regards the enemies of the silkworm but little need be said. It has been generally supposed that no true parasite will attack it, but in China and Japan great numbers of the worms are killed by a disease known as *uji*, which is undoubtedly produced by the larva of some insect parasite.[1]

[1] For a further notice of this fly, and also of the silkworm fly of Bengal which often occasions considerable loss, see No. 2 of these *Notes*.

"With regard to diseases, however, Pasteur, after studying the subject very carefully, concluded that all may be considered as varieties of four principal diseases, *viz. muscardine, pebrine, flacherie,* and *grasserie.*

"These diseases are found to some extent intercurrent, though at times one (at least one of the first three) has been more prevalent than the others, generally amounting to a plague. So in 1849 we find Mons. Guérin Méneville studying, on the part of the French Academy, the then prevalent disease, the muscardine. This was soon followed, in the fifties, by a veritable scourge in which the pebrine was the leading feature, with flaccidity (*flacherie*) quite frequently found. The same learned body appointed Pasteur to study the causes of these diseases, and after two years of patient research, he devised a means, which will hereafter be described, of successfully preventing the return of the pebrine. This made way for flaccidity, which, although it does not reach the importance of a plague, its effects are distinctly visible upon the national crops of cocoons in France and Italy, and I have never known it to be absent from worms reared by me almost every year for nearly two decades in this country (America). The *grasserie* has never attained any such importance, but occurs in rare instances only.

"*Muscardine.*—The first of these, *muscardine,* has been more or less destructive in Europe for many years. It is of precisely the same nature as the fungus (*Empusa muscæ*), which so frequently kills the common house fly, and which sheds a halo of spores, readily seen upon the window pane, around its victim. A worm about to die of this disease becomes languid, and the pulsations of the dorsal vessel or heart become insensible. It suddenly dies and in a few hours becomes stiff, rigid, and discoloured; and finally, in about a day, a white powder or efflorescence manifests itself, and soon covers the body, developing most rapidly in a warm, humid atmosphere. No outward signs indicate the first stage of the disease, and though it attacks worms of all ages, it is by far the most fatal in the fifth, or last, age or stage, just before the transformation.

"This disease was proved by Bassi to be due to the development of a fungus (*Botrytis bassiana*) in the body of the worm. It is certainly infectious, the spores, when they come in contact with the body of the worm, germinating and sending forth filaments which penetrate the skin, and upon reaching the internal parts, give off minute floating corpuscles, which eventually spore in the efflorescent manner described.

"It appears very clear that no remedies are known; but that care in procuring good eggs, care in rearing the worms, good leaves, pure, even-temperatured atmosphere, and cleanliness, are checks to the disease.

"As the sole means of disseminating the disease are the spores, which only appear several hours after the death of the worm, the most rational means of preventing the spread of muscardine is by carefully taking from the tables all dead worms as soon as they are discovered; and if the disease seems to have gained a foothold in the magnanerie, it will be well to remove the litter oftener, and give the worms more space. The spores retain their power of communicating disease for at least three years; hence the importance of cleansing and fumigating.

"*Pebrine.*—The disease pebrine shows itself outwardly by the dwindling away of the worms and their inequality of size. Eating little, they do not grow as large as when in their normal state. At the end of a few days black spots frequently make their appearance on the skin, resembling punctures or burns; the anal horn, the prolegs, the soft parts between the rings, are especially subject to these spots. These spots disappear with the shedding of the skin at each molt only to reappear again within a few days. In addition to these symptoms it is noticed that the

prolegs do not seem to attach themselves easily to objects. In the chrysalis the abdomen is very much swollen, and the rings stretched. In a highly diseased moth the wings are wrinkled as when they emerge from the cocoon, and are often covered with bloody pimples, which become black on drying. Part of the body and wings have a leaden colour. But this must not be confounded with a certain natural brownness which some healthy moths exhibit, and which extends over the whole body: but it is only with highly diseased subjects that these exterior signs become visible, and to find the symptoms of the disease, we are often obliged to resort to microscopical examination of the interior of the insect.

"In the interior of the body microscopical observation reveals the presence of innumerable corpuscles of an ovoid shape filling the cells of the walls of the stomach, those of the silk glands, the muscles, the fatty tissues, the skin, the nerves,—in a word, all the portions of the body. There are often so many of them that the cells of the silk glands become swollen and white, and appear to the naked eye to be sprinkled over with chalky spots; the silky liquid always remains exempt from this parasite, but is much less abundant than when the worm is in a healthy state.

"These corpuscles are found in the silkworm in all its stages in the egg, larva, chrysalis, and moth. It was for a long time a mooted question as to whether they were the true cause or the mere result of the disease; but the praiseworthy researches of Pasteur have demonstrated that pebrine is entirely dependent upon the presence and multiplication of these corpuscles. The disease is both contagious and infectious, because the corpuscles which have been passed with the excrement or with other secretions of diseased worms may be taken into the alimentary canal of healthy ones when they devour leaves soiled by them, and because it may be inoculated by wounds inflicted by the claws of other worms. The malady may be carried to a distance with the corpusculous dust coming from infected magnaneries, and such dust holds the power of communicating disease from one season to another.

"When the *seed* is thus diseased it hatches irregularly and incompletely, and the larvæ often perish before or during the first molt. When the corpuscles are taken into the intestines, as above described, the malady usually becomes apparent, through some of the external symptoms mentioned, at the end of four or five days. M. Pasteur determined that if the worm partook of the soiled food after the fourth molt it would make its cocoon, but that corpuscles would be found in profusion in the chrysalis and moth. If, on the other hand, the worm is thus exposed to contagion just before spinning, the chrysalis will show the parasites only during its last days, while they will be abundant in the moth.

"From the mother moth the corpuscles pass into the egg and give rise to the diseased *seed* already remarked upon. Disease in the male will not, however, affect its progeny. The egg is formed while the insect is still in the chrysalis state, and it has been ascertained that, where the corpuscles become abundant only during the last days of this stage, they enter into the seed to a very small degree only, if at all. For this reason eggs are sometimes found to be entirely pure, though the issue of a highly pebrinous parent. The development and multiplication of these corpuscles, though ordinarily very rapid, is insignificant in the egg until the formation of the larva begins. It will be easily understood that, though the parasite may exist in the vitellus of the egg, its detection may be extremely difficult. But when the development of the embryo has commenced, the number of corpuscles grows also, so that just before, or, better still, just after, the time of hatching, they may be found by hundreds upon a casual observation. Upon a microscopical examination at this time,

Vittadini, in 1859, founded his system of selection, examining samples of eggs just at the time of hatching and rejecting those lots which showed the corpuscular disease.

"At that epoch it was believed that the corpuscles existed even in the healthy moth when well advanced towards its natural death. But Pasteur showed this theory to be fallacious, proving, as we have said above, that the corpuscle is only present when the moth is diseased. He showed that, where the moth is free from the parasite, the egg too would be exempt, and that, as a rule, where the corpuscles exist in the moth, there its issue will probably be corpusculous also. There is, to be sure, even then a chance of its purity, as mentioned above, that is, when the corpuscles become abundant in the chrysalis only after the formation of the egg. But here, too, it is highly probable that the malady will have so affected the general health of the parent as to make her issue more apt to succumb to disease, as in the case of flaccidity. Therefore it is laid down as a rule, and upon this rule the Pasteur system of selection rests, that if, upon microscopical examination of the mother moth, the corpuscles of pebrine are found, then her eggs and issue will also be pebrinous, and should be destroyed.

"*Flaccidity* (*Flacherie*).—When after the worms have passed their fourth molt, and are eating well and regularly, they have all the appearance of perfect health and vigour, and the silk-raiser feels full confidence in the success of his crop; some will often be seen to crawl to the edges of the trays, and lie there languid and without motion. But for the loss of their wonted activity and the cessation of their naturally voracious appetite, one would still think the worms in perfect health, for they yet retain all the outward perfection of form that we have remarked above. In colour they have, perhaps, become somewhat more rosy, especially if the disease is in a violent form. On touching them, however, we find them soft, and even in this seemingly live condition they are often dead. Had the worms been carefully observed at this time, it would have been seen that the beating of the dorsal vessel was gradually becoming slower, and that it finally stopped altogether. A green drop appears at the mouth, and the worm secretes a dirty liquid, which soils the anal orifice and gradually closes it.

"Before many hours are passed the skin begins to shrivel and draw in around the fourth and fifth joints of the body, *viz.* those two lying between the set bearing the legs proper and the set bearing the prolegs. Later, at this restricted point, the body begins to turn brown, then black, and the whole worm is soon in an advanced state of putrefaction. Then, and even before the death of the worm, a sour odour is perceptible in the magnanerie, due to the fatty volatile acids exuded by the victims of the disease. Should the malady strike the insects at a later period, when they are ready to spin their cocoons, the same languishing air will be observed; they will show reluctance to crawl up into the arches, and will be seen to gather around their bases, seeking some place, which it requires no exertion to attain, to spin their cocoon. Many of those which reach the branches stretch themselves out motionless on the twigs and die there. They are to be seen later hanging by their prolegs in different states of putrefaction. When these symptoms are observed, we may be sure that the worms are attacked by flaccidity (*flacherie*).

"A microscopic examination of the intestines of the silkworm will show masses of undigested food, and the coats of the intestines will be found to be opaque. Here too the microscope reveals the parasites ordinarily attending putrefaction, chief among which is a bacillus seen sometimes with and sometimes without a bright nucleus. There also exists a special form of ferment, not unlike that which accompanies the formation of vinegar (*Mycoderma aceti*, Pasteur), which is found in short chains, the

links of which are almost spherical in form. These two parasites are sometimes found together and sometimes separated.

"When the bacillus is abundant, death quickly follows its appearance, and the disease, spreading rapidly, will sometimes destroy a whole school in a single day. At times this bacillus appears so short a time before the spinning of the cocoon that the worms are able to mount into the branches, and even make their cocoons and become chrysalides. Then, however, the disease overcomes them, and their putrefaction produces foul cocoons. This case is, however, more rare, and in general the bacillus is not often found in the chrysalis. When the ferment alone appears the disease progresses differently. The worms then show the same languor on the approach of the spinning period, and the same indisposition to make their cocoons; but even then they mount the branches, perform their work of spinning, are transformed into chrysalides, and these into moths, which may have a fine appearance. The silk crop may even be exceptionally good; but when this state has existed, when the worm has been without its usual agility at the spinning time, when it has shown this apparent laziness, then, though the cocoons be of the firmest and the moths the finest, there will exist a weakness, a constitutional debility, that will show itself in the next generation. This is the only way in which flaccidity is hereditary, in this predisposition of the worm to succumb to disease on account of the affection which weakened, but which did not kill, the parent.

"Flaccidity generally appears after some sudden change in the weather or temperature, as, for instance, a thunder-shower, or a hot, heavy day. It is apt, too, to follow the feeding of wet or fermented food. If the shelves go too long uncleaned and begin to mildew; if the worms are too crowded on the tables and their natural respiration interfered with, flaccid subjects will soon appear in the school. These, by their unhealthy excrement, soil the food of their neighbours, who quickly follow them in the path of disease. It is thus that flaccidity becomes highly infectious.

"No very satisfactory means have been proposed for combating this malady when once it appears. It would be well, on the discovery of the first victims, to take the worms remaining healthy into another apartment, and give them more space and plenty of air. Attentive care may then save the crop, though by no means with certainty. To avoid the disease one should breed only from eggs microscopically selected, though even their circumstances may be against the silk-raiser and the crop be lost through no apparent fault of his.

"*Grasserie.*—This disease is of little importance, and has therefore received but little attention. It is thus described by Maillot (*Leçons, &c.*, page 111):—'In the middle of a school of worms in good condition it is not rare, as a molt approaches or just before the spinning begins, to find here and there some worms which crawl slowly, and have a shining, stretched, thin skin; the body is of a bright yellow in the yellow, and of a milky white in the white races; a troubled liquid transudes through the skin, soiling the food and the worms over which the diseased subjects pass .... A moist cold stagnant air seems to favour the occurrence of grasserie. The disease is not contagious; nor does it appear that it can be transmitted, by heredity. From this point of view there is nothing to be feared unless a great number die of the malady, in which case it will be imprudent to use the stock for reproduction.' Victims of this disease should be removed as soon as discovered, as they are apt to crawl into the branches and soil the cocoons spun by other worms.

"Summing up the diseases to which silkworms are liable, we have:—

"1. *Grasserie*, which is never hereditary, as the victim never dies later than in the chrysalis state, and the disease can never originate in the moth.

"2. *Muscardine*, which is never hereditary, unless the moths mingle with worms covered with the spores of the *Botrytis*, in which case the moth might also catch the disease, and its general debility decrease the vigour of its progeny.

"3. *Flaccidity*, which is hereditary in an indirect manner, a debility springing from the affection of the parent rendering its issue more apt to succumb to disease.

"4. *Pebrine*, which is hereditary in the true sense, the corpuscles passing from the mother through the egg to the next generation.

"In the production of eggs, then, we need look for flaccidity and pebrine only, the other diseases not entering into the consideration.

"*Reproduction.*—The simple process formerly employed in all sericultural countries consisted in stringing the cocoons and letting the moths couple, as in the modern process. A sheet was then hung up with the lower edge so turned as to form a trough into which any badly gummed eggs might fall. After uncoupling, the females were placed upon the sheet and permitted to lay their eggs promiscuously. The only precaution taken against the disease was in the selection for reproduction of lots of cocoons whose larvæ had shown no signs of any malady, and which were themselves of first quality. From what has been said it will at once be seen that pebrine contracted after the fourth molt, and the slow form of flaccidity due to the presence of chain ferment, are not thus guarded against. The modern system has a deeper, more scientific basis, and aims to guard against these.

"*The Pasteur system of microscopical selection.*—As we have seen, pebrine and flaccidity are the only two diseases which it is necessary to guard against in selecting eggs. If pebrine or flaccidity have appeared in a positive form in the larvæ, either through the external or internal symptoms described in the last chapter, no further examination need be resorted to, as the stock will evidently be unfit for reproduction. The most important and positive sign of the latter disease to be looked for is languor at the spinning time. If a greater degree of certainty is desired, or if the egg-producer has not had the opportunity of observing the rearing of the worms, microscopical examination of the chrysalis may be resorted to. In flaccidity this examination should be confined to the stomach, where the chain ferment to be sought for is more easily found. M. Pasteur (*Etudes, &c.*, Volume I, page 233) gives the following directions for extracting this organ: 'Cut away the walls of the thorax of the chrysalis with fine scissors after the manner shown in the figure[1] so as to reveal the stomach. Draw this out with a pair of tweezers. The restricted part of the digestive tube, which unites the stomach with the urinal sack, *u*, should then be cut. The anterior part of the digestive tube now alone holds the stomach in place, and this easily gives way. Lay the small ball thus withdrawn on a glass slide and scratch away the very soft, fatty envelope which covers the interior. Of this interior substance take a piece as big as the head of a pin, wash it with a drop of distilled water, and placing it upon a slide with a cover glass over it, examine it with a microscope magnifying about four hundred diameters. With a little experience this work may be done very rapidly. It would be well to take out at the same time the stomachs of, say, twenty chrysalides, and lay them on as many glass slides.....The first few days after the formation of the chrysalis the contents of the stomach are generally very liquid, which makes their extraction inconvenient. It is better to make these observations seven or eight days after the spinning begins, when the matter will be found to have

[1] Plate IX figure 3.

more consistence.....The ferment found in flaccid chrysalides is associated with the *débris* of leaves, morsels of the trachea, and chlorophyl cells. These matters ordinarily accompany the little ferment in the stomach of the chrysalis, because of the incomplete digestion of the leaf whenever it is submitted to fermentation.'

"No parasite indicative of flaccidity has been discovered other than this ferment, which is not found in the adult insect; and if the transformation into the moth is permitted, all opportunity will be lost for detecting the disease. In pebrine, on the contrary, the corpuscle is found in the moth as well as in the chrysalis. We might therefore wait for a final examination of the moth to be made after oviposition. But, in case disease is then found, it will be too late to stifle the cocoons, and the emergence of the moths will have ruined them for certain commercial purposes. For this reason it is important to detect the disease, if it exists, at as early a stage of the work as possible. If the larvæ have shown no external signs of the pebrine, it would be well to microscopically examine a few of the last of the worms to spin. The corpuscles will be found in these laggards, if anywhere.

"*Isolation and examination of the moths.*—The development of the chrysalis may be hastened or retarded by increasing or lowering the temperature. This fact is taken advantage of to obtain a few adult insects which may be microscopically examined before the whole lot become fully developed. Maillot (*Leçons*, page 250) describes the method he adopts in France as follows:—

"'Three or four days before the cocoons are taken from the branches, we take, here and there, from the early spinners as well as the late, several hundred cocoons; as, for example, 500 from a lot of 90 pounds. This sample should be placed in an oven or warm room, where it will be kept day and night at a temperature of 100° to 110° Fahrenheit and a high degree of humidity. In this way the formation of the moth is hastened. As during this time the cocoons of the lot itself remain at a temperature of from 75° to 90,° and often during the night at even lower temperatures, we shall still have time to stifle them if the lot is discarded, or to string them into chains if, on the contrary, it proves healthy. Every two days we take ten chrysalides from the sample and examine them microscopically for corpuscles. If we find them in the first eight or ten days, no matter in how small quantities, we can be sure that the proportion of pebrinous moths will be considerable. When the chrysalides are mature, which is easily seen by their eyes becoming black and the eggs harder to break under the pestle, and also by some of them turning into moths, we proceed to the definite examination. We crush one by one the moths which have come out and the chrysalides which remain and search for corpuscles; the percentage which is thus found will not differ materially from that which exists in the whole lot.'

"The examination of the chrysalides here mentioned may be made in the manner already described when searching for the ferment of flaccidity and at the same time. But if we are looking for the pebrine only, we need simply crush the whole chrysalides in the manner hereafter described for the moth. Proceeding now with the stock of which the purity has been ascertained by one or more of the different methods of observation above described, 200 cocoons should be selected for each ounce of eggs that it is desired to produce. In making this selection great care should be exercised in taking only cocoons that are fine in texture and firmly made. This fineness is one of the pre-requisites of a first class cocoon. The firmness of a cocoon, depending as it does on the amount of silk which it contains, is an indication of the vigour of the worm, and another item to be considered in selecting stock for reproduction. Rules have been given for the determination of the sex of the inclosed insect, but this

selection of sex is comparatively unimportant, and we consider it wiser to choose the cocoons in relation to their firmness and texture, and trust to chance to bring as many male moths as female. Double cocoons, when two worms have spun together, should never be used in egg-making.

"The proper cocoons having thus been selected, they should be strung upon stout threads about three feet long. Care should be taken not to prick the chrysalis with the needle while passing it through the end of the cocoon in making the chains. These chains should then be hung in a cool darkened room, while waiting for the moths to emerge. Previous to this emergence there should be prepared for each ounce of eggs to be produced about one hundred small bags of fine muslin cheese-cloth, made in the following manner: cut the cloth in pieces 3 by 6 inches, fold one end over so as to leave a single edge of about three-quarters of an inch broad and sew up the sides so as to make a bag with the upper end open, then turn it inside out, so that the seams will cause the sides to bulge. These bags, or *cells*, should be strung on a cord stretched across the room. The moths emerge from the cocoons, as a rule, from 5 to 8 o'clock in the morning. At the latter hour many of them will be found coupled and clinging to the chains. These should be carefully taken by the wings and placed upon a table by themselves, the single moths being placed upon another table, where they will couple if the sexes are evenly divided. They should then be transferred to the first table, as the fluttering of the male moth is apt to disturb the couples. They should be left together until 4 or 5 o'clock in the afternoon, when they may be separated by drawing them gently apart by the wings. The females should then be placed in the cells or upon the cloths already described, where they will at once commence egg laying, completing it in about 36 hours. Most of the males may then be thrown away, though it may be wise to keep a few of the more active ones to compensate for any superabundance of females in the issue of the following day.

"When the eggs have been laid, the microscopical examination of the moths should be made with a view to ascertaining whether or no they are afflicted by pebrine. The entire moth should be ground up with a few drops of distilled water in a small glass mortar (2-ounce is a convenient size). A drop of this water is then taken with a medicine dropper and placed upon a glass slide with a cover slip over it. It is then microscopically examined with a power greater than 300 diameters. When the moths are not examined until some time has elapsed after their death, they will be found to contain other germs peculiar to putrefaction. These do not indicate any disease that would affect the egg or its issue; nor does the presence imply any lack of vigour in the parents. They are simply *post-mortem* parasites. Great care should be taken in cleansing the mortar, pestle, and other implements, before making an examination, by washing them in an abundance of water and rinsing them thoroughly with distilled water. In making the above examination only the corpuscles of pebrine need be looked for, as the bacilli and ferments of flaccidity are rarely found in the moth.

"*Choking the chrysalis.*—In cocoons which are not intended for breeding, some means must be used to kill the contained chrysalis, before the cocoon is injured for reeling purposes by the egress of the moth. This can be done by stifling them with steam or choking them by dry heat. Steaming is the surest, quickest, and best method if the facilities are at hand; it can be done at any steam mill. The cocoons are laid upon shelves in a tightly sealed box and the steam turned in. Twenty minutes will suffice to do the required work, and the cocoons are then dried in the sun. The dry heat method occupies a much longer time. The cocoons are placed in shallow baskets and slipped on iron drawers into an oven, which is kept heated to a temperature of about 200° Fahrenheit. This should not be increased for fear of

burning the silk. This operation lasts from 2 to 24 hours. A certain humming noise continues so long as there is any life, and its cessation is an indication that the chrysalides are all dead. When the choking is well done there is little loss, only about one per cent. of the cocoons bursting at the ends. After choking in this manner, the cocoons should be strewn upon long wooden shelves in the shade, with plenty of air, and, for the first few days, frequently stirred. After remaining on these shelves for about two months, with occasional stirring, the chrysalides become quite dry, and the cocoons will preserve indefinitely. They are however still liable to the attacks of rats and mice, and the little beetles known as *Museum pests*, belonging to the genera *Dermestes* and *Anthrenus* are attracted by the dead chrysalis within, and will penetrate the cocoon, injuring it for reeling purposes."

The following is an extract from a letter, dated 8th July 1887, by J. A. Anderson, on Susani's egg-rearing establishment at Mouza, Italy :—

"Signor Susani is the largest grower of seed in the world.... Pasteur, he said, had given up the whole thing years ago. He told them what to do, and they had to find out how to do it on a proper system, and really the whole matter is *system*, for in a place like Susani's the work is enormous. He employs 300 to 500 microscope women during the inspection time, and as these are peasant girls for the most part, you can fancy what that means.

"The worms (in the beginning of June) were either in the last stage, or spinning or had just finished. They are in numbers of well ventilated pucca houses standing at good distance from each other, and everything as clean as can be.

"As the butterflies come out they are taken by pairs and put into little bags of coarse muslin about 3″ × 2″. Susani uses several millions of these, all exact size and cloth, with a string to pull the mouth together. The muslin is stiff, and a small block is used to give the bags a round shape before putting in the flies. The bags are hung on frames, the eggs laid, and the assorting begins.

"Each bag is placed in a small box with a pestle and mortar, the bag at one end and pestle and mortar at the other : ten of these boxes fit into a tray. One girl will do 40 or 50 trays (400 to 500 specimens) in a day. As each tray is finished an inspector tests one as a check (1 in 10), and an over-inspector tests one in every ten that the sub-inspector does.

"If any girl is found to have made a mistake, the whole of her work of that day must be checked. An inspector can do 600 to 700 specimens, as he works much faster than an uneducated peasant. If any pair is found to contain disease, the eggs are at once thrown away by the girl. The mortar remains so that her work can be checked, but the seed is at once thrown away, so that there can be no mistake about it.

"The damage to microscopes is a very serious item ; he has 650 (400 power), and half of these have to be repaired every season,—the girls smash them so. They cost 73 francs each in Milan.

"The eggs are taken in November and put in a cold room, and the temperature kept till 15th March at from 0° to 5° Centigrade. (He has two refrigerators, in case one breaks down.) They then begin to raise the heat gradually till they put the eggs to hatch. There is a hot air apparatus in all the places as well.[1]"

[1] From the diary of Mukharji, who was deputed to Europe in 1888 to study the silk question, it appears that in order to reduce the percentage of diseased moths, amongst those he rears to produce eggs for sale, Susani does his rearing from fifteen to twenty days before the regular rearing season of the district commences ; thus lessening the liability to infec-

BOMBYX FORTUNATUS.[1]

Desi or *Chota Polo.*

[Plate VIII (C).]

This is a small multivoltine variety of the mulberry silkworm; it is largely reared in Bengal, where it yields the principal cold-weather crop of cocoons. The cocoons are generally golden yellow in colour, and, compared with the European annual variety, they are small and of loose consistency. Cleghorn observed that the moths are dusky in colour, the worm being bluish-white without distinctive marking; while Hutton noticed that the variety can be distinguished from all other varieties by the fact that when near to maturity the caterpillar becomes of a dull leaden blue colour.

The following is an abstract of Mukharji's report upon the species:—

The rearers prefer a south aspect for the rearing house, but all rearing houses do not face the south; they are covered with specially thick thatch, and generally have but one small window and a door. The window is always kept shut at night, and during the cold season in the day time also; the door is always kept shut at night and in the cold weather all chinks are carefully filled up, the fermenting refuse from the trays being often piled up inside the rearing house to further raise the temperature.[3] In one rearing house in the cold weather Mukharji found as many as thirty-two trays, each tray containing about 2,500 worms, besides a man with his wife and children and a cow. He does not give the dimensions of the house, but notices that this was rather an exceptional case, the rearing house being generally set apart for the worms, though one or two men usually sleep in it with the idea of protecting the worms

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tion by germs of disease from other establishments. In order to obtain the necessary leaf for this early rearing, the mulberry is forced by manure to produce leaf earlier than it would otherwise do; but the supply is sometimes insufficient. Mukharji mentions other seed-rearing establishments, where the percentage of disease is reduced by raising the insects in isolated localities.

[1] *Bombyx fortunatus*, Hutton: Trans. Ent. Soc., Lond. (3), ii, p. 312, pl. 19, fig. 3, (1864-68).
" " Hutton: Journ. Agri.-Hort. Soc., Ind., iii, p. 125 (1871).
" " Moore: Proc. Zool. Soc., Lond., 1867, p. 683.
" " Wardle: *Wild Silks of India*, p. 3 (1881).
" " Rondot: *L'Art de la Soie*, Vol. I, p. 312 (1885).
" " Mukharji: Report dated 6th January 1888.
" " Cleghorn: Letter dated 9th April 1888.

[3] The necessity of keeping up the temperature in the rearing houses, during the cold weather, is shown by the failure of Mukharji's attempt to rear worms in some old barracks without following the usual method of keeping the place warm.

from supernatural influence. These men, both by the warmth of their own bodies and by letting in the air when the room becomes too hot, and by stuffing up the cracks and crannies when it is too cold, for their own comfort, no doubt, as Cleghorn suggests, unconsciously tend to keep the conditions of the atmosphere suitable for the worms; they thus furnish an example of the practical utility of a custom which is followed on account of the supernatural benefits supposed to be derived from it.

The moths emerge from their cocoons within eight or ten days after the spinning has been completed. The caterpillars molt four times within a period of about 25 days, at the end of which time they are ready to spin. As they gradually grow bigger they are distributed over a larger and larger number of trays. The worms are fed three times a day in the cold weather and four times a day in the hot. The trays are cleaned about once every five days; and as the worms are moved by hand, the cleaning is often very imperfect, and by the time it takes place the tray is covered with a fermenting mass of leaves, excreta and dead worms, upon the top of which the live worms are feeding.

When full fed, the worms are removed by hand to cocooning trays, which are fitted with a coiled strip of basket-work, about two inches broad, along which the cocoons are spun. The spinning takes about two days to accomplish, so that the whole period which elapses between the bringing in of the seed and the selling of the cocoons is about 35 to 40 days. Some seven or eight crops of cocoons could be raised in the course of the year, if it were desirable to do so, but as a matter of fact, the rearing is only done in the regular bunds, both because a continuous supply of mulberry leaf cannot usually be obtained and because the presence of the silkworm fly *Trycolyga bombycis*, referred to on p. 134, renders continuous rearing inadvisable.

BOMBYX CROESI.[1]

Nistry or *Madrassi*.

This is a small multivoltine variety of the mulberry silkworm; it is reared chiefly in the March and rains bunds in Bengal, where it is second in importance to the *Desi* variety. It is also reared in Assam. Like the *Desi* it produces a succession of crops throughout the year,

[1] *Bombyx croesi*, Hutton: Trans. Ent. Soc., Lond. (3), ii, p. 312 (1864-66).
" " " Journ. Agri.-Horti. Soc., Ind., iii, p. 125 (1871).
" " Moore: Proc. Zool. Soc., Lond., 1867, p. 683.
" " Wardle: *Wild Silks of India*, p. 3 (1881).
" " Stack: *Silk in Assam* (1884).
" " Cleghorn: Letter dated 9th March (1888)

most of which are only reared for seed. Unlike the *Desi*, however, it thrives best in the hot weather. The cocoons, which are generally yellow, at least externally, are somewhat larger than *Desi* cocoons, but the fibre has less elasticity and brilliancy. The moth is milky white in colour, the caterpillar is milky white with two black spots on each segment; it is reared like the *Desi*, of which it appears to be little more than an artificial variety.

BOMBYX ARRACANENSIS.[1]

Or Nya paw.

This is a multivoltine mulberry silkworm closely allied to the *Desi* and *Madrassi* of Bengal; it is reared in Burma.

The following account of it is taken from Manuel's paper published in the Journal, Agri-Horticultural Society, India :—

"*Bombyx arracanensis.*—The domesticated silkworm of British Burma was named by Captain Hutton, who believed it to be a species distinct from any of those domesticated in Bengal.

"Silk-growing is a profitable occupation in this province; nevertheless it is not followed largely. . . . . The industry has its chief seats at Tharrawaddy, Prome, Thayetmyo, and Toungoo. Spinners and weavers of silk are found in other places, as in Henzada, Shwegyin, Tavoy, and Mergui, but the occupation of breeding, with few exceptions, is confined to the higher latitudes of the country, on the slopes of the Pegu and Arakan Yomas.

"The chief food-plants are the red and white mulberry, the latter being preferred. But the Agricultural Department has lately introduced the Philippine variety, which seems likely to be an improvement upon the white.

"The local worm is multivoltine, and completes its cycle of existence in from 32 to 43 days. The length of the cycle, however, depends on the season of the year; it is longer in the cool weather and shorter during the warm; the silk yield of the cool weather is, however, finer than at other times. The average weight of a single fresh cocoon is 12 grains; and the *seed*, as the eggs are commercially termed, are sold in the bazaar.

"It takes the female moth one or two days to deposit all her eggs, which average from 200 to 250. The pieces of cloth on which the eggs are laid are put away till the sixth day, when they are taken out and inspected. By this time the worms have matured in the eggs, which have changed colour from white to deep yellow,

[1] *Bombyx arracanensis*, Hutton, Trans. Ent. Soc., Lond. (3), ii, p. 313 (1864-6).
" " " Journ. Agri.-Horti. Soc. India, iii, p. 125 (1871).
" " British Burma Gazetteer, I, p. 412 (1880).
" " Moore, Wardle's *Wild Silks of India*, p. 3 (1881).
" " Manuel, Journ. Agri.-Horti. Soc. India, N. S., VII, p. 291 (1882-85).
" " Report of the Lyons *Laboratoire, D'etudes de la soie*, p. 10 (1886).
" " Roudot, *L'art de la soie*, ii, p. 483 (1887).

and finally to dark-purplish slate. On the eighth day the worms begin to appear as tiny black specks. The egg cloth is then covered with tender mulberry leaves to which the worms speedily crawl. The earliest risers are considered the best worms, and the worms which do not crawl at all are considered too weak and worthless and are usually rejected. The selected ones are then kept in large circular trays, being fed in them without any change of bed and without being disturbed in the least. In these trays during all their life they molt, defecate, and here the refuse of their food accumulates till the mass attains to almost the level of the tray. By that time the worms show by their restlessness and their attempts to spin that they are *ripe;* they are then picked out by the hand and deposited in the cocooning trays. These are of large size, from three to four feet in diameter, and within them is a long ribbon of plaited bamboo a couple of inches broad, wound round with the edges on the flat of the tray, in a helix or spiral. The worms are scattered over these trays by the handful without any care or regularity, and, left to themselves, they soon begin to spin. . . . They finish the *cradle* in about six hours; in eight or ten hours the worms have disappeared from view, and in from 24 to 36 hours the cocoon is completed. In from 48 to 50 hours the last transformation is effected, and then the insect sleeps for eight or ten days, and eventually emerges a moth. The male is active and restless, seeking a mate; the female remains quiet until found by a male.

"The whole treatment of the worm from its first entrance into the world to the time it disappears from sight within its silken enclosure is careless, slovenly, and dirty. No separate place is provided, except it be that a portion of the family sleeping-room is screened off with a *kalaga*. The trays are never changed, the excreta never removed, the refuse of the food never cleared out, and all this, with the sloughs of the molts together with the silk the worm makes at all times, form a dense matting of stinking, fermenting materials, which must be deleterious to the healthy growth of an insect so sensitive as the silkworm. Under such circumstances it would be surprising if the worms were not subject to disease. Enquiries amongst the breeders of Kynegyi and Shwelag proved the truth of such suspicions. As a matter of fact the mortality amongst the worms was said to be always great, and sickness often swept away large broods. Hence the men were anxious to secure *seed* of the Bengal worm; and as a matter of fact breeders rarely depend on their own *seed* to any great extent, but purchase fresh stock annually from the itinerant Shan traders who bring in quantities of eggs from the Karen States beyond the frontier.

"After the cocoons have matured and before the exit of the moths, they are prepared for reeling. Torn away from the cocooning trays by handfuls, they are thrown into baskets, and then the women and children of the family divest the *pods* of all their *waste* or floss. Then, without sorting or selection of any kind, except that the yellow and white *pods* are kept apart, the cocoons are put into a chattie, or earthen pot, of water and slowly simmered over a fire. The reeler, generally a woman, who makes it her sole business to reel silk, tries the pods after they have simmered for a while, and as soon as she finds the fibre come away easily, she picks up a handful of cocoons each by a thread of silk,—the number usually being from 18 to 25,—shakes them well to a sufficient length, and then runs them through a loop of brass wire on to a reel fixed to a pair of cross-sticks of bamboo. From the reel the filaments are given a slight twist and carried on to a cylinder of wood with a handle and turning on a trestle. One woman manages the whole operation. She sits beside the fire opposite the pot over which the cross-sticks with the loop and reel are supported. In her right hand she holds an iron fork, with which she regulates the outcome of the threads from

the pot, and with her left she turns the handle of the cylinder of wood, on which the silk is reeled. Some practice is necessary to attend to and carry out operations with both hands, so as to produce a tolerably even and fine thread, and good reelers generally command good wages in their villages, so that it is difficult to get one to leave her home.

"As much silk having been obtained from the cocoons as it is possible, the pods are then taken out of the pot, and, while still moist and warm, are stretched into a kind of coarse knubby thread which finds a sale in the markets for coarse work. The chrysalis, now divested entirely of its silken covering, is taken up by the children and eaten either fried in oil or unfried.

"The silk thus obtained is coarse and unfitted for export, though it answers very well for the well-known fabrics *tamaings*, *lungyis*, *pasos*, worn by the Burmese."

In his *L'art de la soie*, volume II, page 483 (1887), Rondot writes of *Bombyx arracanensis*, that five generations of the worm are reared in the year in Burma, no rearing being done between the 16th January and the 22nd June. The fibre is about 22·9 thousands of a millimetre in thickness, its tenacity being 6·56 grammes and its elasticity 17 per cent.

BOMBYX TEXTOR.[1]

Boro polo or *large pat.*

This is an annual mulbery silkworm, larger than either the *Desi* or *Madrassi*. It produces a considerable amount of good silk, and is occasionally reared in Assam and Bengal; owing, however, to the fact that it produces but one crop of cocoons in the year, and that its eggs do not hatch simultaneously, its cultivation has now been generally abandoned. Rondot, in his *L'art de la soie*, writes that this variety spins a white cocoon smaller than that of *Bombyx mori*, and differing from it both in form and structure, being generally pointed at each end, a little soft, the silk not closely wound, and containing comparatively little gum. He notes that in the early part of the century this variety was reared almost everywhere in the Kasimbazar circle and other places in Bengal, and that it has also been found in Ceylon.

The following is an extract from Stack's report on silk in Assam, dated February 1884:—

"The peculiarity of the *bor polu*, or large *pát* silkworm, is that the period of hatching lasts ten months. To this circumstance it owes its name of *lehemia* or

[1] *Bombyx textor*, Hutton, Trans. Ent. Soc. Lond. (3), ii, p. 309 (1864-6).
" " " Journ. Agri. Hort. Soc. Ind., iii, p. 125 (1871).
" " Moore, Proc. Zool. Soc. Lond., 1867, p. 683.
" " " Wardle's *Wild Silks in India*, p. 2 (1881).
" " Louis, *A few Words on Sericulture in Bengal*, p. 20 (1880).
" " Stack, *Silk in Assam*, February (1884).
" " Rondot, *L'art de la soie*, Vol. I, p. 320 (1885).
" " Hunter, Gazetteer of India, Vol. III, p. 7 (1885).
" " Mukharji, Report dated 6th January (1888).
" " Cleghorn, Letter dated 9th March (1888).

slow. During this time the eggs are kept in a piece of cloth deposited in a wicker basket (*japá*), which is carefully placed out of the reach of rats and insects. The cultivators look for the appearance of the young worms about the time of the festival of the first day of *Mágh*,—that is, towards the middle of January, when the mulberry is putting forth green shoots.

"The worms are fed at first on young mulberry leaves cut into pieces and shred over them. They change their skin four times. After the second molting they are able to feed on entire leaves. A hundred worms in this stage will eat about one seer of leaves in a day. The tending of the worms usually devolves upon the women and infirm members of the family. The life of the worm lasts thirty to forty days, of which ten or twelve days elapse between the final molting and maturity. The mature worms are removed to a basket divided into compartments, each allotted to two or three worms. Here the cocoons are spun.

"The cocoon is completed in about six days. Those selected for breeding are placed on a sieve. The moths emerge in about a fortnight (the time is also stated as ten to twenty days, according to the heat of the weather), and remain in pairs on the sieve for three days, when the females are taken away and placed on a cloth suspended in some quiet corner [1] where they deposit their eggs, and die a day or two later.

"About 7 per cent. of the cocoons are reserved for breeding. Their price for this purpose runs as high as one rupee per hundred.

"The cocoons intended for use are placed in the sun, to destroy the life of the chrysalis. This having been effected, a score of cocoons are thrown into a pot of scalding water, and stirred with a splinter of bamboo; the fibres attach themselves to the bamboo, and a thread is thus carried to the reel and reeled off. Sometimes the bamboo fails to pick up the filaments, and a twig of the *makudi* creeper with the leaves on has to be employed.

"The cocoon is of a bright yellow colour, but the silk, when boiled in potash water, becomes perfectly white. About 320 cocoons yield a tola of thread; hence 25,000 to 30,000 will yield a seer.

"From the breeding cocoons after the escape of the moth, and also from the refuse of reeled cocoons, a coarser thread, called *lát*, is made by spinning. One thousand such cocoons weigh about 4½ tolas, and yield a thread about one quarter as valuable as the same weight of reeled yarn.

"The *pát* silk is a much rarer and more valuable article than either *eri* or *muga*. The thread sells for R16 to R24 per seer, and the cloth for R3 to R4 per square yard. Like the *mezankuri* variety of *muga*, the *pát* silk is rather an article of luxury than of ordinary trade. If a piece is wanted, it usually has to be made to order. Nothing like a market for *pát* thread or cloth can be said to exist. The breeding of the worms is restricted by custom to the *Jugi* caste, who used to supply the requirements of the *Ahom* kings and their courts, and the industry is hardly known out of the district of Sibságar, the ancient centre of *Ahom* rule. The *Jugis* still make a profound mystery of the business, refusing to let a stranger see the worms, and answering enquiries in a manner calculated to mislead. They say, for instance, that the worm takes nine months to spin its cocoon. There can be little doubt that the production of *pát* silk has greatly declined since the annexation of Assam, nor is there any prospect of its

[1] In his account of the Birbhum District, Hunter notices (Gazetteer, Volume III, page 7, 1885) that the eggs are preserved in earthen pots closed with a plaster of cowdung and earth from March, when they are laid, until the following January or February, when they hatch.

revival. Writing to the Government of India in 1877, Colonel Keatinge observed that the question of extending the *pát* silk industry need not be seriously discussed."

BOMBYX SINENSIS.[1]

"*Sina*," "*Cheena*," or "*Chota pat.*"

A small multivoltine mulberry silkworm which produces cocoons inferior to those of the *Desi* or *Madrassi*. It is found in Bengal, but its cultivation has been almost entirely abandoned.

The following is an extract from Hutton's paper in Journ. Agri. Horti. Soc. India, III, page 125 (1871) :—

"*Bombyx sinensis.*—This is known as the *sina* of Bengal, but, like the others, it originally came from China ; it is very prolific, and even at Mussoorie goes on yielding crop after crop, up to the middle of December. The cocoons vary in colour some being white and others yellow, while others even have a beautiful faint-greenish hue. There is a peculiarity about these also which may enable the tyro to distinguish them from any of the others ; while all the other species hatch slowly during the morning, from six to twelve o'clock, the *sina* worms come forth all in a batch, or continue hatching all day and all night."

Other Bombyx Silkworms.

In the Indian Museum Report for 1886, Wood-Mason designates a variety of silkworm from Cuddapah and Coimbatore in the Madras Presidency, as *Bombyx meridionalis ;* it seems very doubtful, however, whether this variety is distinct from the *Chota pat* of Bengal. Rondot, in his *L'art de la soie* (Volume II, page 483, 1887), describes the cocoons as small, soft, generally much *satiné ;* in colour white, pale sulphur yellow, or very pale green ; fibre 19·5 thousandths of a millimetre in diameter, its tenacity varying from 3 to 4·5 grammes, and its elasticity from 6 to 8 per cent.

Besides the above there is a species (originally described by Drury in his work on insects written in 1782), which has been classified amongst the Bombyx silkworms under the name of *Bombyx lugubris ;*[2] beyond the bare description, however, nothing seems to be known about it, and it may, therefore, be neglected. From Drury's figure it may possibly be one of the species of *Theophila* which are found wild in many parts of India.

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[1] References—*Bombyx sinensis*—
Hutton, Trans. Ent. Soc. Lond. (3), ii, p. 313 (1864-6).
„ Journ. Agri. Hort. Soc. India, iii, p. 125 (1871).
Moore, Wardle's *Wild Silks of India*, p. 3 (1881).

[2] Vide *Catalogue of the Moths of India* by Cotes and Swinhoe, No. 1097.

TUSSER.

Antheræa Mylitta, Drury.

[Plate X.]

This insect, which is very variable in appearance and has been described under a number of synonyms,[1] feeds on many different plants,[2] and is found in a wild state in jungle land up to four or five thousand feet elevation[3] all over India: a closely allied or identical form is also found in Ceylon.[4] The cocoons always command a price in the market, and are accordingly collected by jungle tribes wherever sufficient quantities can be found to be worth carriage, while the insect is regularly cultivated on the Central Indian plateau for the production of silk. The moths emerge from their cocoons in the beginning of the rains (June), copulate and lay eggs; from these eggs emerge caterpillars which become full-fed and spin cocoons which produce moths about August; these moths lay eggs which produce the worms of the second generation, and these worms spin at the end of the rains (September), yielding the cocoons which in their natural state remain on the trees throughout the winter and produce moths in the commencement of the following rains (June).

The cocoons, which are each attached to the food-plant by a silken stem of singular strength and neatness, are hard and compact in structure, and contain a large amount of coarse, strong, buff-coloured silk, inferior in brilliancy only to the silk of the *Muga* worm (*Antheræa assama*). The cocoons can be reeled, but have first to be subjected to the

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[1] Tusser = *Antheræa mylitta* (Hübn. Walker, Moore, Aurivillius, Wardle, Roudot, &c.) = *Phalæna* (*Attacus*) *mylitta* (Drury) = *Attacus mylitta* (Blanch) = *Bombyx mylitta* (Fabr. and Oliv.) = *Phalæna paphia* (Cramer and Roxburg) = *Antheræa paphia* (Moore and Beavan) = *Saturnia mylitta* (Westw.) = *Saturnia paphia* (Helfer). For details of the synonymy, see *Catalogue of the Moths of India* (Cotes and Swinhoe), p. 228, Calcutta, 1889. Besides the above, which have long been admitted as identical, Hutton described *Antheræa nebulosa* as a distinct form from Chota Nagpur and Central India: Hutton's type specimen is in the Indian Museum, and is obviously only a dark-coloured individual of the common tusser.

[2] Besides the trees—*Shorea robusta* (sal) and *Terminalia tomentosa* (saj)—on which the tusser is usually reared, Wardle, in his *Wild Silks of India*, notices that the following are food-plants: *Rhizophora calceolaris, Terminalia alata glabra, Terminalia catappa, Tectona grandis, Zizyphus jujuba, Bombax heptaphyllam, Careya sphærica, Pentaptera tomentosa, Pentaptera glabra, Ricinus communis, Cassia lanceolata, Lagerströmia indica, Carissa carandas, Terminalia arjuna*, and *Ficus benjaminia*; while Cameron in his report for 1887-88 states that in Bangalore tusser has been found to feed on *Dodonæa viscosa, Webera corymbosa, Shorea talura, Terminalia arjuna, Anogeissus latifolia, Cipadessa fructuosa*, and *Canthium didynum*.

[3] The late Otto Möller noticed that he had never met with the species in Darjiling (7,000 feet), though it is common at the foot of the Darjiling hills.

[4] Described by Moore, in his *Lepidoptera of Ceylon*, London, 1882-83, under the name of *Antheræa cingalesa*.

action of some powerful solvent (*e.g.*, caustic potash) to separate the threads.[1]

Both the cement with which the caterpillar hardens the walls of its silken cocoon and also the fluid with which the moth afterwards softens this cement, prior to working its way out by the help of its wing spines, appears to be secreted in the alimentary tract and to be of excrementitious origin.

With regard to this cement, Major Coussmaker wrote (February 1880):—

"One of the most interesting and I think important facts that I have this year been able to prove, is with regard to the composition of the cement with which the caterpillar hardens its cocoon.

"Former analyses of this agent made for me in England by Dr. Taylor and in Bombay by Dr. Lyon, had shown that it contained the acid urate of ammonia, and it was in fact excrementitious; and this year, by opening the cocoons at various intervals, I was able to convince myself of the fact that when the caterpillar has left off feeding and begins to spin, it voids the food remaining in the alimentary canal, first of all in a more or less solid form and of a dark colour, but after it has become fully enveloped in the cocoon the excrement comes away as a light-coloured liquid, the hue and consistency of which depend upon the amount of vegetable matter not previously evacuated, and the amount of lime, carbon, and ammonia present. The respective proportion of these ingredients vary, I presume, with the food on which the caterpillar has to feed, and with the state of the atmosphere at the time of spinning."—(*Wardle.*)

With regard to the natural solvent of this cement, the observations of the writer seem to show that the solvent fluid, which is stored in a large bladder-like dilatation in the lower portion of the digestive tract of the future moth, can be freely poured out through the anus of the moth into the chrysalis case; but the chrysalis case itself prevents its passing into the lower portion of the cocoon. Now, the moth emerges through a longitudinal dorsal slit in the thoracic segments of the chrysalis, and, in its struggles to extricate itself, it forces this fluid between its body and the chrysalis case through the slit, on to the cemented wall of the cocoon, precisely in the spot where the moisture appears and the softening of the cement takes place prior to the moth's working its way through. It would at first sight appear likely that this excreted fluid, being milk-like in consistency, would, in bathing the abdomen of the moth inside the chrysalis case, stain the delicate scales and hairs with which the moth is covered: that this is not the case, however, is at least indicated by the fact that much of the fluid has been found inside chrysalis cases from which unstained moths have just emerged.

[1] One of the greatest difficulties in reeling *tusser* silk, after the cocoons have once been softened, is to make the separate strands cohere in the reeled thread; this difficulty does not occur in the case of mulberry silk where, unlike the tusser, the cement is only softened in the reeling basin, so that on again hardening it serves to glue the strands together.

Tusser cultivation in Central India.

In Chota Nagpur and the Central Provinces, where tusser is cultivated by *Sontalis*, *Dhimars*, and other jungle tribes, mostly of low caste, the cocoons are collected each year in the jungle, in the early part of the hot weather, when the foliage is thin, and are brought into the village before the rains commence; fresh cocoons being obtained each year.[1]

The moths emerge from the cocoons in the early part of the rains; the females remain clinging to their cocoons where they are fertilized, usually by wild males which fly in from the jungle and which are supposed to be often attracted from considerable distances; the male moths, after emerging from the cocoons, usually take flight and disappear without copulating with the females of the same crop. After fertilization the moths are put into little baskets made of grass, in which they lay their eggs. These baskets are then hung up in the branches of the pollarded trees, which have been prepared to receive them, by bending down the branches and clearing away the rubbish and vegetation around them.

In Chota Nagpur the worms are reared on *Shorea robusta* (*sal*, or *sakooa*), and *Terminalia tomentosa* (*saj*, *assun*, *asain*, or *en*); cocoons are also found on *Zizyphus jujuba*. In the Central Provinces they are chiefly reared on *Terminalia tomentosa*.

The worms, which emerge from the eggs, crawl out of the baskets and are allowed to wander over the foliage at will. Constant watching, however, is required to protect them from birds and insects. They feed on the leaves, and, after molting several times, spin themselves up into cocoons, which, however, are only used for producing a second crop of cocoons, which are formed in the latter part of the rains, and which are the ones that are made into silk.

Under favourable circumstances it is said that about 80 worms can be raised from the eggs of one female, while about 44 per cent. of the cocoons produce female moths. According to Captain Brooks (as quoted by Wardle), the caterpillars molt five times at intervals of from five to eight days; when first hatched they weigh but one fifth of a grain, and are about a quarter of an inch long; but at the end of their larval existence, which extends over from forty to forty-five days, they are sometimes as much as seven inches long, an inch in diameter, and weigh about 370 grains. They then begin to spin their cocoons, from which the moths

[1] Except by the *Bhoyahs* and *Ghatwals* of Chota Nagpur, who keep seed cocoons from one year to another. They tie the cocoons up in bundles in October, and expose them to the atmosphere, at the end of a long pole, through the cold weather and until February, when they bring them into their huts and hang them up until required for rearing in June. —(*Dumaine.*)

soon emerge, to lay the eggs from which is raised the main crop of cocoons at the end of the rains.

The rearers carefully watch over and protect the worms, and while rearing is going on, live with great cleanliness and self-denial, abstaining from alcohol and all intercourse with women, and adhering very strictly to certain ceremonial observances. The business is a very precarious one, much depending on favourable weather, any stoppage of the rain being most injurious to the worms, especially if it occurs when moulting is going on.[1] The insects also are most subject to the attack of enemies of various kinds. The moths are said to be eaten by bats, rats, and ants, while they are still hanging to the cocoons. The caterpillars are said to be eaten by rats, snakes, toads, wasps, ants, and also by a Hemipterous insect (*Canthecona furcellata*), wherever they can be got at; they also perish in large numbers from the attack of *Ichneumonidæ* and *Tachinæ*[2] which are parasitic on them; while in the Central Provinces, at least, they are said to be particularly liable to disease, it being no uncommon occurrence for the whole of a crop of worms to die off, leaving the *Dhimars* without any return whatever for their time and labour.

The chrysalids inside the cocoons intended for reeling are generally killed by steaming, and the cement of the cocoon is softened in some alkaline solution, such as that obtained by mixing the ashes of the dried seed-pods of the pulse *Phaseolus radiatus* (*urd*) in boiling water.

Tusser in Assam.

In Assam tusser does not appear to be cultivated to any appreciable extent, its place being to a great extent taken by the *muga* silkworm (*Antheræa assama*), which is reared much in the same way. The tusser insect, however, is undoubtedly found wild in Assam.

In his report on Silk in Assam (February 1884) Stack writes:—

"The wild silkworm called *kutkuri* is believed to be the same as the common tusser of Bengal. Its food is principally the *kutkuri* (*Vangueria spinosa*) from which it takes its name, or else the plant called (erroneously) the wild Rhododendron (*Melastoma malabaricum*), the Assamese name of which is *phutuka*. It has been cultivated in the palmy days of the Assam silk industry, but it is now almost entirely neglected as being inferior to *muga*, and, also, perhaps, because it yields only three[3] broods in the year. Its habits are now known only to a few old people in Jorhat. Mr. Bucking-

[1] In attempts made in the Indian Museum to raise tusser worms in captivity, in perforated zinc breeding-cages, it was found that, though the eggs hatched out readily, producing vast numbers of apparently healthy worms, these worms invariably died, although supplied with plenty of fresh food. At length, at the suggestion of Mr. J. Cleghorn, daily watering of the worms with a watering-pot was tried in imitation of the heavy rain to which they are exposed in their native jungles, and it was found that, when regularly watered, a certain number could easily be reared through all their stages.

[2] Mons. J. Bigot has determined the Tachinid fly forwarded to the Indian Museum as parasitic on tusser worms in Singhbhoom, as *Masicera grandis* of Walker.

[3] In Central India tusser yield but two.

ham, to whom I am indebted for most of my information about this worm, says that the *kutkuri* is common in the wild state in the neighbourhood of Jorhat. It is also common in Cachar, but there also no use is made of it. Some worms reared in June and July took rather more than a month from the laying of the egg, to the spinning of the cocoon.

"The worms were fed on the *phutuka*. Worms put outside while very young were speedily devoured by ants, but if kept indoors till the second molting, they were then found to do very well on the bushes. Mr. Buckingham adds :—'I reared ten worms in this way, and all except one made their cocoons between the leaves of the shrub, one solitary worm descending and making its cocoon in the grass. The natives had previously informed me that this wild species of worm was less liable to the attacks of crows, bats, &c., than tame species were, and it was curious to watch how the worm, at the slightest show of danger, let go the leaf or stem with all its front legs, hanging on by its holders behind, and in this position, with its head slightly curled round and its front legs well tucked up, it took an experienced eye to detect the difference between the leaf of the tree and the worm.'"

"Some worms reared by Krishna Kanta Ghugua spun their cocoons on 7th October, the moth emerged on 10th April, and laid their eggs which hatched, and formed cocoons on 21st May, the chrysalis state thus lasting sixth months.

"The only point in which the *kutkuri* cocoons seemed to Mr. Buckingham to differ from those of the Bengal tusser, was that the tusser cocoon was rather closer spun and more compact, and less pointed at the ends than the *kutkuri;* but the colour was as nearly as possible the same.

"The silk is ranked below *muga* in value, being coarse though glossy, and so strong that the natives compare it to rhea thread. The *phutuka* is one of the commonest wild shrubs in Assam, and the worm could probably be cultivated at very little cost, but the silk could not compete with the cheaper and better tusser supplied by Bengal.

"Another worm which appears to be simply a variety of the tusser, feeding on the *phutuka*, like the worm just described, is counted by the Assamese as a distinct species and known by the name of *Deomuga*. It must not be confounded with the genuine *Deomuga* described further on. An experiment was made with cocoons of this (so-called) *Deomuga* by Krishna Kanta Ghugua." The cocoons were obtained on 14th August, the eggs were laid, and the worms reared and spun up by the 22nd September, moths again emerging in the following March.

"The wild silkworm called *Sálthi* is also a species of tusser. It is called *Deomuga* by the Kacharis, but must not be confounded with the *Deomuga* proper, which is described below, and which is a *Bombyx*. The *Sálthi* worm feeds on the *Kamranga* (*Barringtonia racemosa*) and the *Hidál*. The worm itself is very rarely met with, but herd-boys and wood-cutters occasionally bring home the cocoons, and the silk obtained from them can be used for mixing with *Eri*. To extract it, the cocoon has first to be boiled in a strong alkaline solution, and afterwards bruised in a mortar. The hollow cocoon is often converted into a tobacco-box, or is used to keep lime in for eating with the betel-nut, or as a cup for dipping oil out of a jar. The habitat of the worm is the jungle at the foot of the Bhutan Himalayas. The chrysalis of this species, as of all the wild silkworms, is eaten with much relish by the Kacharis."

Tusser in the Punjab.

Tusser cocoons are met with extensively, in a wild state, throughout the submontane districts of the Punjab, chiefly on *Zizyphus jujuba* (the *ber* tree). It does not appear, however, that the insect has ever been reared otherwise than experimentally for the production of silk.

The following is an extract from a note published in the Journal Agri. Hort. Soc. India, N. S., VI, 1878-81 :—

"The cocoons exhibited are part of a crop reared this autumn in Hoshiarpur. The worms are semi-domesticated, *i.e.*, the eggs are collected from the moths and hatched out in the house, and then put on the *ber* trees, which have to be watched while the worms are feeding. They spin their cocoons in from 20 to 40 days. The cocoons collected in the winter burst in June. The moths lay their eggs, and the worms hatch out in 9 days, and after 30 or 40 days' feeding spin their cocoons. These cocoons are ready by the end of August and September. These cocoons again burst in 21 days, and another crop of worms and cocoons is produced, the insect being bivoltine, or going through all its metamorphoses twice in the year. The cocoons of the second batch which are found in October lie dormant all the winter, and burst in the succeeding June or July, just after the first burst of the rains, when the *ber* tree is putting forth tender shoots, on which the young worms thrive.

"The industry has not been taken up by the natives as yet, but it has been shown that rearing the worm here is possible, though there are many difficulties to overcome, and large numbers of the worms die before coming to maturity."—(*Coldstream.*)

Tusser in Hyderabad.

In the Annual Report of the Government Central Museum, Bombay, for the year 1859-60, Dr. (now Sir George) Birdwood notices that the rearing of tusser, and the preparation of silk from it, is largely carried on in Hyderabad. In the Indian Museum there is a series of different stages of the insect from Hyderabad, prepared by Captain Catania at the instance of the Nizam's Government.

Tusser in Bombay.

In the Journal, Soc. Arts, June 1883, are published extracts from Major G. Coussmaker's report to the Government, recording the failure of his attempts to grow or obtain tusser cocoons at such a price as to be remunerative, though he abundantly shows that the cocoons can be easily raised in the Bombay Presidency. Major Coussmaker reared the worm experimentally on a considerable scale in Poona, but the industry does not appear to have been taken up commercially.

The following are some of the chief sources of information on the subject of tusser in India :—

Helfer, Journ. As. Soc. Bengal, VI, 1837.
Hutton, Journ. Agri. Horti. Soc. Ind., III, 1871.
Forsyth, Highlands of Central India, page 367, 1871.
Stack, *Report on Silk in Assam*, 1880.
Coldstream, Journ. Agri. Horti. Soc. Ind., N. S., VI, 1881.
Wardle, *Wild Silks of India*, 1881.
Coussmaker, Journ. Soc. Arts, 1883.
Note on Handicrafts of the Central Provinces, author (?), date (?).
Dumaine, Journ. Agri. Horti. Soc. Ind., N. S., VII and VIII, 1887.
Roudot, *L'art de la Soie*, II, 1887.

ERI.

Attacus ricini,[1] Boisd.

[Plate VIII (a).]

This is a multivoltine silkworm which is fed on the leaves of the castor-oil plant and reared entirely indoors in Assam, much in the way that the mulberry worm is reared in Bengal. It is cultivated throughout the whole of Assam, particularly in the submontane districts, the industry being mostly in the hands of non-Hindu tribes of low caste.

Each female moth lays about 200 eggs, which, under favourable circumstances, hatch in a week to a fortnight after being laid; the worm molts four times, and becomes full-grown and commences to spin in a fortnight to a month after emerging from the egg. The moth emerges and lays its eggs in a fortnight to a month after the formation of the cocoons. The cycle of existence of the insect, in its various stages, thus takes from 5 to 11 weeks to complete; this variation being chiefly due to temperature, cold retarding and heat accelerating the process, as is the case with the mulberry worm of Bengal. As many as eight generations of the insect can thus, under favourable circumstances, be gone through in the year, but the number actually reared does not exceed five or six. Most of the rearing goes on in the cooler portion of the year, the chief crops of cocoons being generally obtained in November, February, and May, respectively, and worms being reared during the rains, more to keep up the stock than to produce silk.

The cocoons are somewhat loose in texture and either white or deep brownish red in colour. Those of them that are intended to be made into silk are stifled, either by exposure to the sun or over a fire; and when required for manufacture, the chrysalids are cut out, and the silk cocoons softened by boiling in some alkaline solution. The silk is spun, by hand, into a more or less uneven thread, which is woven locally into a coarse, but particularly soft and durable cloth. Reeling of the cocoons, though possible, is not adopted.

A most complete account of the insect has been given by Stack in his report, dated February 1884, on silk in Assam. The following there-

[1] The following is the synonymy of the species:—

Saturnia ricini, Boisd. Ann. Soc. Ent., France, 1854.
Attacus lunula, Walker, B. M. Cat., 1855.
Philosamia lunula, Butler, Ill. Typ. Sep. Het. B. M. V., 1881.
Attacus ricini, Moore, Cat. Lep. Mus., E. I. C., 1859.
Hutton, Journ. Agri. Hort. Soc. Ind., 1871.
Warnford-Lock, Journ. Soc. Arts, 1880.
Wardle, *Wild Silks of India*, 1881.
Stack, *Silk in Assam*, 1884.
Rondot, *L'art de la Soie*, 1887.

from is quoted *verbatim* from his report, foot-notes only being added in cases where further information has been obtained :—

"The *eri* worm (*Attacus ricini*) derives both its scientific and its vulgar name from its attachment to the castor-oil plant (*Ricinus communis*), called *eri* in Assamese. It feeds also on the *keseru* (*Heteropanax fragrans*), and there are several other trees, as the *gulancha* (*Jatropha curcas*), the *gomari* (*Gmelina arborea*), and even it is said the common *bogri* or *ber* tree (*Zizyphus jujuba*), which the worm can thrive on in its later stages, if other food is not procurable in sufficient quantity. The *eri* worm is a multivoltine, and is reared entirely indoors. The castor-oil plant grows abundantly in the ryot's garden, springing up from dropped seed in every little patch of unoccupied land around his house. The tending of the worms devolves principally upon the women of the family, and goes on all the year round. As many as eight broods can be obtained in twelve months, but the number actually reared never exceeds five or six, and depends a good deal upon the quantity of food which chance has provided for the worms, since no care is taken to ensure a supply by planting out trees. It is the autumn, winter, and spring broods spinning their cocoons in November, February, and May respectively, which are chiefly destined for use, and of these the spring cocoons are the most numerous, and yield the most silk. The broods of the rainy months June to September are reared for the purpose of perpetuating the stock. But both breeding and spinning, to a greater or less extent, go on all the year round. Cocoons reserved for breeding are placed in a round basket woven of bamboo, with a narrow mouth, and are hung up in the house out of the way of rats and insects. After about fifteen days in the hot season, and 20 to 30 days in the colder months, the moths emerge and are allowed to move about in the basket for four-and-twenty hours. The females, distinguished by their larger body and broader and flatter abdomen, are then tied to pieces of reed or *ulu* grass, by a ligature passing under the shoulder joint of a pair of wings on one side of the body only, leaving the pair of wings on the other side free. Ten moths will thus be tied to a piece of reed two feet long. The males, though left at liberty, do not attempt to fly away, but remain with the females, to which they have attached themselves, until the latter have laid their eggs, when the males depart. If some of the females, as may easily happen for want of any criterion of sex in the cocoon, are unprovided with males, they are exposed on the eaves of the house in the evening, and are visited by any stray males that may be in the vicinity. The female lays about 200 eggs in three days, and the life of the moth lasts a day or two longer.

"The eggs are picked off the straws, wrapped in a piece of cloth, and hung up in the house. The period of hatching varies with the season; in the month of May, with an average temperature of 83°, Fahrenheit it has been found not to exceed a week, but in the winter it is about fifteen days, and in the months of medium temperature nine or ten days is the usual term. When the eggs begin to hatch, the cloth is opened, and tender leaves of the castor plant, previously crushed between the fingers to render them still softer, are supplied to the young worms for food, and subsequently they are transferred to a bamboo tray suspended in a place of safety. As the worms grow stronger, older leaves are given to them. Their supply of food is occasionally intercepted by swarms of caterpillars[1] appearing on the castor-oil plant about the month of June.

[1] Specimens of a caterpillar, reported on by Mr. Mackenzie as having proved most destructive to castor-oil plants, used for rearing *eri* in Cachar, have been forwarded to the Indian Museum by Mr. R. S. Greenshields, Officiating Director of Land Records and Agriculture, Assam. They prove to belong to the species *Achaea melicerte*, a Noctues moth which has also been reported as destructive to castor-oil plants in Lower Bengal and in Madras. See *Indian Museum Notes*, Vol. I, pp. 52 and 104.

These must be carefully removed from the leaves that are given to the silkworms, and the leaves themselves washed in water. It is at seasons like these that the leaves of a variety of trees are used as substitutes for the favourite food of the worm. Large numbers of the worm are lost by disease, of which neither the nature nor the remedy is known,[1] but which probably has its origin in uncleanliness. No care is taken to remove the excreta, nor are the dead worms regularly rejected. The native account of the disease is simply that the worm ceases to eat and withers away. Some good effects are said occasionally to follow from sprinkling water, in which *tulsi* leaves have been steeped, over the worms among which this disease has made its appearance. The ichneumon fly is a deadly enemy. Its bite,[2] which leaves a black mark, usually proves fatal to the worm at the next molting; and if the wound has been inflicted after the last molting, the worm spins a smaller cocoon, and dies before it is completed, leaving the eggs of the fly to hatch inside the cocoon.[3] Rats are still more destructive, sometimes sweeping off an entire brood in a single night. The cultivator is careful to abstain from praising his crop of worms, lest any of these calamities should overtake them.

"The number of moltings is four, known locally as *hâludia*, *duirkâta*, *tinirkâta*, and *châirikâta*; the first term denotes the yellow colour of the worm, the three others merely mark the order of the moltings. Mr. Thomas Hugon, who held the office of Sub-Assistant (corresponding to the present office of Assistant Commissioner) in the Nowgong District, contributed a very carefully written paper upon the silkworms of Assam to the Proc. As. Soc. Bengal for 1837, whence the following description of the worm is taken: 'The caterpillar is first about a quarter of an inch in length, and appears nearly black.' (The colour is, perhaps, more exactly described as a blackish yellow.) 'As it increases in size, it becomes of an orange colour, with six black spots on each of the twelve rings which form its body. The head, claws, and holders are black; after the second molting they change to an orange colour; that of the body gradually becomes lighter, in some approaching to white, in others to green, and the black spots

[1] Some alcoholic specimens of *eri* worms which had died of a disease reported on by Mr. Mackenzie as having proved most fatal to worms in Cachar, were sent to the Indian Museum, in August 1889, by Mr. R. S. Greenshields. On microscopic examination of the digestive tracts of some of the caterpillars, the chain ferment *Streptococcus bombycis*, which is characteristic of *Flacherie* in the mulberry silkworm (see p. 146), was made out in one instance. Ferments of this kind are always very difficult to make out in alcoholic specimens, and the not finding it in large quantities does not therefore affect the practical certainty that the disease is *Flacherie*, while Mr. Mackenzie's description of the symptoms, which were precisely those of the *Flacherie* of the mulberry silkworm, leaves no room to doubt that the disease was actually *Flacherie*. This discovery is somewhat remarkable, *Flacherie* being a disease which, in the case of the mulberry worm, is so intimately connected with the fermentation of the mulberry leaf, that it might have been supposed that it would not attack the *eri* worm, feeding as it does on a different plant. Pasteur's remedy for *Flacherie* in mulberry silkworms will no doubt be found to be applicable to the *eri* (see p. 146). A further and more careful examination of the specimens has since been made, but the ferment has not been recognized in the sections prepared. The observation, therefore, of its presence requires confirmation.

[2] The ichneumon fly destroys the caterpillar, not by biting it, but by depositing an egg, which develops into a grub which feeds on its tissues, the caterpillar succumbing to the internal injury caused by the grub.

[3] The *eri* worm is also attacked by the Tachinid fly, *Trycolyga bombycis*, a parasite which is most destructive to the mulberry silkworm in Bengal. A detailed account of it is given in *Indian Museum Notes*, Vol. I, pp. 77-88. This is not improbably the "Ichneumon" described by Stack.

gradually become the colour of the body. After the fourth or last molting, the colour is a dirty white or a dark green. On obtaining its full size, the worm is about $3\frac{1}{2}$ inches long.' According to one series of observations, it would appear that in the hot months the first change of skin occurs three days after hatching, and the rest follow at intervals of three days, while the worm begins to spin on the fourth day after the final change, or the fifteenth day after hatching. In the cooler months, the period before each molting is four or five days, making 20 to 25 days between hatching and beginning to spin; and in the winter season the worm lives a whole month or even longer. After the final molting, the worms are transferred from the tray to forked twigs of the castor-oil plant, with the leaves on, suspended across a piece of reed. As the worms attain maturity they cease to feed, and crawl to the top of the fork; and if held up to the ear, and gently rolled between the fingers, their bodies emit a crackling or rustling sound. They are now placed in the *jâli*, which consists of a bundle of dried plantain leaves, or of branches of trees with the withered leaves attached, and this also, like the feeding tray, is suspended from the roof within-doors. Here they begin to spin, usually on the same day, and not unfrequently two worms will select the same leaves for their covert, and join their cocoons together. The time occupied in spinning is three to six days.

"The dimensions of a full-sized cocoon are about $1\frac{1}{5}$ inch in length by $\frac{3}{4}$ inch in diameter. The cocoon without the chrysalis weighs five grains. It is destitute of floss. Its proper colour is white, but a large proportion of the cocoons are of a brick-red colour, for which it is difficult to account. . . . . Worms of the same brood, fed on the same leaves, will produce dark and light cocoons indifferently. The dark colour can be purged away by boiling the cocoon in alkali water. There seems to be reason to believe that, with proper care in providing the worms with suitable shelter for spinning, the proportion of white cocoons could be increased, and the quality also of the silk could be improved." (Mr. Stack instances experiments made by Mr. C. H. Lepper, and adds):—"Some cocoons spun in a wine-case nearly filled with loose shreds of newspapers, and with the lid closed, proved to be perfectly white and exceptionally good.

"In preparing the cocoon for use, the first step is to destroy the life in the chrysalis. For this purpose exposure to the sun during one or two days is usually sufficient, and this is the method preferred by the cultivators as enabling them to keep the cocoons longer and avoiding the discoloration which is caused by fire. When fire has to be employed, it is applied under bamboo trays upon which the cocoons are placed. Cocoons intended for immediate use are boiled for two or three hours in an alkaline solution of the ashes of the plantain stem in water, which serves the double purpose of killing the chrysalis and softening the cocoon. Usually, however, the cultivator keeps his cocoons until he has a stock sufficiently large to make it worth his while to begin to spin. He then boils them in the solution described above, or the ashes used may be those of grass, rice-straw, or the stems and leaves of the castor-oil tree, or of various other plants. In this way cocoons several years old, if they have been kept uninjured, can be softened and rendered capable of spinning. After this process the cocoons are opened and the chrysalis is extracted; they are next washed white, slightly kneaded in the hand, dried in the sun, and are then ready for use. The *eri* cocoon has been successfully reeled in Italy, and experiments have shown that it can be reeled in India, but the only method employed by the cultivator is that of spinning off the silk by hand. At the time of spinning the empty cocoons are placed in an earthen bowl containing water, with which a little cowdung is sometimes mixed. Each cocoon is taken up separately, and the silk is drawn off in a coarse thread, nearly as thick as twine. Uniformity of thickness is roughly preserved by rubbing the thread between the finger and thumb, and in this way also new cocoons are joined on. It is said that six spinners can spin about 4 chittacks (8 oz.) of thread in a day, consuming thereby

some 1,200 to 1,500 cocoons. A seer (2 lbs.) of empty cocoons will yield about three quarters of a seer of thread.

"The *eri* worm is cultivated to a greater or less extent in every district of the province. Being regarded as of doubtful purity, it is left principally to *Rábhas, Meches, Kacháris, Mikirs, Kukis,* and other non-Hindu tribes. In the submontane country inhabited by the *Kacháris* and their cognates, along the north of the districts of Goálpára, Kámrúp, Darrang, and Lakhimpur, almost every house has its patch of castor-oil plants, on which the *eri* worms are fed. In some parts of this region the Marwari traders make advances to the cultivators in October, when the revenue is falling due, and take repayment afterwards in thread or cloth, and both these products are commonly exposed for sale in the petty markets, in the same manner as other articlea of village merchandise. A good deal of *eri* is also produced in the district of Sibsagar, and in Upper Assam generally the ryot may be seen swathed in a warm sheet of coarse *eri* cloth in the winter mornings and evenings. Throughout the whole range of the southern hills, from the Mikir country to the Gáro, *eri* thread is in great request for weaving those striped cloths in which the mountaineers delight. An estimate of 183 cwt. (250 maunds) has been furnished for the outturn of the North Cachar section of these hills, and a similar amount for the Khasi Hill district. The *Mikirs, Kukis,* and *Garos* cultivate the worm for themselves, but the handsome and durable cloths worn by the *Khásis* and *Santengs* are woven of thread procured from *Mikir* and *Kuki* breeders inhabiting the lower hills on the northern and southern faces of the range. All these people eat the chrysalis with avidity, considering it especially delicious in the form of curry. *Eri* is but little cultivated in the plains of Sylhet and Cachar.

"In the absence of any large markets, and indeed of any regular trade in either the thread or the cloth, it would be quite useless to attempt to conjecture the probable outturn of *eri* silk in Assam. An estimate of 25½ cwt. (35 maunds) has been furnished for the produce of Kamrup, 177 cwt. (242 maunds) for Darrang, and 205 cwt. (280 maunds) for Nowgong, but the latter district probably produces less *eri* than either of the other two, and the estimates may be regarded as mere guess-work. In no district does the produce do much more than supply local wants. A trade in cocoons, to the extent of 400 or 500 cwt. yearly, has sprung up between Goalpara and Calcutta, whence the cocoons are shipped for England. They are said to come chiefly from Upper Assam. The cloth which finds its way to the shops of the Marwari traders is by them exported to Bengal. The mountaineers of Bhutan who visit the plains in the winter carry away with them a considerable quantity both of cloth and yarn. The quantity of cloth is estimated at 2,000 pieces, while the yarn is dyed by the Bhutias and woven into gaily-coloured coats and striped cloths, some of which find their way back to the bazars of Assam. The value of the silk thus exported from the three Butia fairs in the Darrang District last year (1883) was returned as ₹43,000, and probably we may allow as much more for the Bhutia trade in Kamrup. As regards its use in the province, however, the general opinion is that the native *eri* is being supplanted by cotton goods from England. It is alleged that the cloth is procurable with more difficulty now than formerly, and it is certain that the price has risen greatly within the last thirty years. If we go back so far as fifty years, we find the yarn selling for ₹2 a seer in 1834" (while in 1884 Mr. Stack estimates its price at from ₹4 to ₹7 per seer). "There is, however, reason to doubt whether *eri* was more easily procurable then than it is now, and perhaps the rise of price is chiefly to be explained by the influx of money which has accompanied the development of tea cultivation. It is impossible to say whether the actual outturn is less or greater now than at any former period. There is no natural obstacle to an increase of production to any imaginable limit."

MUGA.

Antheræa assama,[1] Westw.

[Plate XI.]

A semi-domesticated silkworm which is cultivated in the open in the Assam Valley, much in the way that *tusser* is cultivated in the Central Indian plateau; though the *muga* is somewhat more domesticated than the *tusser*, its eggs being hatched, and its cocoons spun indoors.

It is reared on the *sum* tree (*Machilus odoratissima*), and on the *sualu* tree (*Tetranthera monopetala*), but will also feed on the leaves of other trees, *e.g.*, the *mezankuri* (*Tetranthera polyantha*), and the *champa* (*Michelia sp.*), upon both of which it is said to have been reared in considerable quantities in former years, the silk produced by the worms fed on these trees being known as *mezankuri*[2] and *champa* respectively, and being considered as whiter and of better quality than ordinary *muga*.

The insect goes through a regular series of about five generations in the year; of these, however, only two or three are usually reared in Upper Assam, seed cocoons reared during the rains in Kamrup being usually imported for the purpose of rearing the cold season and spring crops of silk in Upper Assam.

The female moth, after fertilization, either by a male from the same batch of cocoons, or by a wild male from the jungle, lays about 250 eggs; these hatch in from seven days in the warm months to ten days in the cold, in baskets made for the purpose, and generally kept indoors. After they have hatched out, the young are put upon the trees, where they feed in the open on the leaves, and where they are carefully watched by the rearers to protect them from the attack of their various enemies, such as crows, kites, and other birds, bats, wasps, ichneumonidæ, and ants. The

[1] The following is the synonymy of the species :—

Saturnia assamensis, Helfer, Journal, As. Soc. Beng., VI, 1837.
Saturnia assama, Westw., Cab. or Ent., 1848.
Antheræa assama, Walker, Cat. Lep. Het. B. M., 1855.
Moore, Cat. Lep. Mus., E. I. C., 1859.
Warnford Lock, Journ. Soc. Arts, 1880.
Wardle, *Wild Silks of India*, 1881.
Stack, *Silk in Assam*, 1884.
Rondot, *L'art de la soie*, 1887.

According to the above, Helfer's name of *assamensis* should be adopted, if it were not that the insect is so widely known under the name *assama* that any change of the kind would simply produce unnecessary confusion.

[2] The silkworm which produces *mezankuri* silk has been distinguished by Moore, under the name of *Antheræa mezankooria*. There appears, however, to be no reason to suppose that it is in any way distinct from the ordinary *muga*, the difference in the silk produced by it being on all sides admitted to be due entirely to the difference in food.

worms molt four times and become full-fed in from 26 to 40 days according to the temperature; they are then brought indoors by the rearers and spin their cocoons on bundles of twigs prepared for the purpose; the chrysalis stage lasting from a fortnight to a month. A complete generation thus occupies from nearly two months in the warmer portion of the year to nearly three months in the cold.

The cocoons intended for the production of silk are stifled by exposure to the sun, or over a fire, and when required for manufacture, are softened by boiling in some alkaline solution; the floss is plucked off, and they are reeled by hand. The floss, and also the waste that remains after reeling, is used for mixing with *eri*. The reeled *muga* is woven locally into cloth which is yellowish in colour, and much like *tusser* in consistency though of far greater brilliancy.

The following is extracted from Stack's report on silk in Assam, dated February 1884:—

"The scientific name of the *muga* silkworm (*Antheræa assama*) denotes its peculiar connection with Assam. . . . . Its Assamese name is said to be derived from the amber colour of the silk, and is frequently used to denote silk in general, so that *erimuga* means *eri silk*, *kutkuri muga*, tusser silk, and so on; the genuine *muga* being distinguished by the title of *Sompatia muga*, or silk yielded by the worm that feeds on the *sum* leaf. It is a multivoltine worm, and is commonly said to be semi-domesticated, because it is reared upon trees in the open air; but in fact it is as much domesticated as any other species, being hatched indoors and spinning its cocoon indoors, while during its life on the tree it is entirely dependent on the cultivator for protection from its numerous enemies. The *sum* tree (*Machilus ordoratissima*) furnishes its favourite food; but in Lower Assam it is extensively bred on the *sualu* (*Tetranthera monopetala*). The leaves of certain other forest trees, the *dighlate* (*Tetranthera glauca*), the *patichanda* (*Cinnamomum obtusifolium*), and the *bamroti* (*Symplocas grandiflora*) can be eaten by the worm in its maturer stages if the supply of its staple food begins to fail; but the *sum* and the *sualu* are the only trees upon which the worm yielding the ordinary *muga* silk (as distinguished from *champa* and *mezankuri*, which will be mentioned hereafter) can be permanently reared. The *sum*-fed worm is considered to yield the more delicate silk, and *sualu* trees on the edges of *sum* plantations are generally left untouched, though small plantations of *sualu* only may occasionally be met with.

"Five successive broods are distinguished by vernacular names roughly denoting the months in which the worms are bred and spin their cocoons. These are the *Katia* brood in October—November; the *Jârua* in the coldest months (December—February); the *Jethua* in the spring; the *Aharua* in June—July; and the *Bhadia* in August—September. But it is only in a few parts of the Assam valley that this regular succession of broods is maintained. The *Aharua* and *Bhadia* broods are reared chiefly in the district of Kamrup, whence cocoons are exported for the *Katia* brood in Upper Assam. In Darrang and Sibsagar the only broods for use are the *Katia*, *Jarua*, and *Jathua*; while in Lakhimpur only the *Jarua*, and *Jathua* are generally in fashion. The worm is said to degenerate if bred all the year round in Upper Assam; and another reason for the discontinuance of breeding in the summer is that the *sum* forests are flooded by the rains, the watching of the worms becomes more troublesome, and losses increase. Hence, the breeders of Upper Assam generally go down to Kamrup or Nowgong to buy cocoons at the beginning of the cold season. Occasionally a *Bhadia* brood of

inferior quality is reared in Sibsagar on a high-lying patch of *sum* land. Even in Jorhat, the centre of the cultivation of the *muga* silkworm, one fourth of the breeding cocoons, it is estimated, are imported from Kamrup. The price of cocoons thus purchased varies from R2 to R4 the thousand, according to the supply. Sometimes the worms themselves are sold at the rate of 100 to 150 per rupee.

"The cocoons intended for breeding are placed on trays of woven bamboo, and hung up safely within the house. The period of the chrysalis lasts about a fortnight in the warm months, and three weeks or a few days longer in the cold season, when the room in which the cocoons are kept has to be warmed by a fire, and they are sometimes suspended near the hearth. If the worms are kept in a covered basket, the moths are allowed to move about inside it till the day following their emergence; but when open trays are employed, the female moths, recognizable at once by their bulkier body, are immediately tied by a thread passing round the thorax behind the wings to single pieces of straw, which are hooked on a line stretched across the room; or several moths may be fastened in this way to a bunch of straws 18 inches long by 1 in diameter. Straws black with smoke are usually selected from a notion that the colour helps to reconcile the moth to captivity. The male moths are left free, and some of them make their escape into the open air, but the majority remain attached to the females. Any deficiency in the number of males is supplied by placing the females outside the house in the evening, when unattached males will discover and consort with them. A song chanted by the cultivator is supposed to attract the males on such occasions. Each female produces about 250 eggs in three days, and the life of the moth lasts one or two days longer, but eggs laid after the first three days are rejected as likely to give birth to feeble worms. The pieces of straw with the eggs deposited on them are carefully taken down and placed in a basket covered with a piece of cloth. The room in which they are kept is heated by a fire in winter, or the eggs may be laid in a place warmed by the sun, but not directly exposed to his rays, the heat of which would prove destructive. They ought to be kept in the dark as much as possible. The period of hatching lasts from seven to ten days, according to the time of year. In the summer months it is not necessary to keep the eggs indoors at all, and they can be placed on the tree at once, with due precautions, however, against sun, rain, and dew; and even in the winter a small proportion of the eggs may be placed out unhatched, together with the young worms: generally, however, the worms are hatched indoors. 'On being hatched' (says Mr. Hugon) 'the worm is about a quarter of an inch long; it appears composed of alternate black and yellow rings. As it increases in size, the former are distinguished as six black moles, in regular lines, on each of the twelve rings which form its body. The colours gradually alter as it progresses, that of the body becoming lighter, the moles sky-blue, then red with a bright gold-coloured ring round each.' The worm passes though four moltings, known respectively as *chaiura*, *duikâta*, *tinikâta*, and *maiki-châl-kâta*. The full-grown worm, when extended in the act of progression, measures about five inches long, and is nearly as thick as the forefinger. Its colour is green, the under-side being of a darker shade, while the back is light green, with a curious opaline or transparent tinge. Excluding the head and tail, the body is composed of ten rings, each having four hairy red moles, with eight gold bases, symmetrically disposed round its edge; a brown and yellow stripe extends midway down each side from the tail to within two rings of the head, and below it the breathing-holes are marked by a series of seven black points; the head and claws are light, enclosing a large black spot. Two sizes of the full-grown worm are distinguished—the *borbhogia* is five inches long, the *horubhogia* somewhat shorter; and a similar difference is observed in the size of the cocoons. It is not necessary that the worms should complete their growth on a single tree. If the leaves be exhausted, they descend the trunk till they are stopped by the coil of straw rope or by a band of plantain leaves, which serves

to arrest them till they can be gathered and transferred to another tree. This may be done either by simply placing them on the trunk and leaving them to crawl up . . . . or by means of a triangular tray, which is pushed at the end of a long bamboo, and hooked on to one of the upper branches. The latter is also the method employed in putting the young worms on the tree for the first time. Young trees are preferred to begin with, and generally trees from three to twelve years old are considered the best. Old trees are avoided, as they harbour ants, and the moss on their branches impedes the movements of the worm. The worms feed from about eight o'clock in the morning till near noon, and again from three to sunset. During the intervening hours they descend the trunk to bask in the sun, and at night they take shelter under the leaves. A dropping sound like that of light hail is heard under the tree at feeding time, and is caused by the pea-like excrement (*lád*) of the worms, which is constantly falling to the ground.

"During their life in the open air the worms are exposed to the attacks of various enemies, among whom the crows and kites are the most persistent and destructive, but the *sáksákia*, or wandering pie, by day, the aziola, or 'little downy owl' (*pesa*), and the large frugivorous bat (*bandali*) by night, are also to be dreaded. The insects which do most damage are the wasp, the ichneumon fly, and a red ant called *amrulli*, but the latter is dangerous to the worm only in its earlier stages. The result of a bite is a blackness extending from the injured part over the whole body, which gradually withers away. The cultivators wage war against the ants with fire and hot water, or skewer bits of fish on the trunk to attract them and prevent them from ascending the tree; the pellet-bow is used against the birds by day, and a tall clapper of split bamboo pulled by a string from within the watcher's hut serves to frighten away nightly marauders; but with all these precautions he losses by theft are considerable. This constant watching becomes very troublesome, especially in the months of inclement weather, and is usually left to the children and old people, where there are any in the family. Continued heavy rain is apt to wash the worms off the trees, but they can shelter themselves under the leaves against passing showers, and, in fact, light rain in October and November is considered favourable to the growth of the winter brood. A hail-storm is the greatest calamity of all, for it not only kills numbers outright, but so weakens others that they die before maturity, or spin imperfect cocoons, and the weakness is even said to be transmitted to the moths if any emerge. The worms, finally, are subject to a disease called 'the swelling' (*phula-rôg*), for which no remedy is known. In Upper Assam this epidemic occasionally destroys the worms on acres of *sum* forest together, and even where the mortality is less wholesale, the silk-producing power of the survivors is found to be impaired. The worms often die off in large numbers without any swelling or other external symptoms, merely ceasing to feed, and perishing apparently of inanition, and in this case also the yield of silk from the surviving portion of the brood is poor. Apart from these causes, a difference is said to be noted in the productive powers of worms of the same breed. It is alleged that some worms can be distinguished as destined to die immature; these are called *hahoya* and *bisa*; others, called *phutuka*, spin cocoons yielding an imperfect quantity of silk.

"The period from hatching to maturity varies from 26 days in summer to 40 days in winter. The moltings are completed about a week or ten days before the end of this term. There is no difficulty in discerning when the worm is ready to begin its cocoon, because it invariably descends the tree to the edge of the plantain leaf band, and there remains motionless, grasping the bark with its holders only, while the fore part of the body is raised and thrown slightly back. Another sign is said to be a peculiar sound yielded by the body when lightly tapped. Worms which show these symptoms are removed at nightfall, or, if left overnight, they begin to make their preparations for spinning in a roll of grass tied round the tree for that purpose.

Being carried to the house, the worms are then placed on a bundle of branches with the dry leaves attached, or in a basket with a bundle of leaves suspended over it, into which the worms crawl. A complete cycle of the insect last about 54 days in the warm months, and 81 days in the cold season.

"The *muga* cocoon is in size about $1\frac{3}{4}$ inch long by 1 inch in diameter. In colour it is a golden yellow ; but there are usually a number of dark cocoons in every brood, for which no satisfactory reason can be assigned. The difference does not seem to be due to any of the conditions of food or breeding. A large proportion of the dark cocoons which come into the market, however, are no doubt to be accounted for by discoloration in the process of firing. Boiling in alkali water is the method employed to restore cocoons to their proper colour. With the living chrysalis inside, the cocoon weighs about 66 grains, with the dead and dried chrysalis $27\frac{1}{2}$ grains, and the empty cocoon from which the moth has made its escape weighs 6 grains only. The ordinary selling rate for cocoons with the dessicated chrysalis is R2 the thousand, but they can often be bought in the villages for 700 or 800 the rupee. The waste or perforated cocoons from which the moth has escaped can be had for about R2 the seer, containing nearly 3,000 cocoons. There is, however, no regular market for cocoons, and persons wishing to procure a stock visit the villages where the worms are bred, and make their own bargain with the cultivators, and waste *muga* cocoons do not seem to be easily procurable by any artifice.

"The silk of the *muga* is reeled. The life of the chrysalis having been destroyed by exposure to the sun, or by fire, the cocoons are boiled in an alkaline solution. When required for use, their floss is plucked off, and they are placed in a pot of warm or cold water. Two persons are employed, one to take the silk from the cocoons, the other to reel it. The former brings together the filaments of silk from a number of cocoons, varying from 7 to 20, and hands them to the reeler, who rubs them into a thread by rolling them on his thigh with the palm of his right hand and the under part of the fore-arm (which usually suffers more or less from the operation), while with his left hand he turns the fly-wheel of the primitive reeling apparatus that stands beside him, an axle turning in the notches of two uprights, with the aforesaid wheel at one end, or often merely a cross-stick in the middle to serve the purpose of a fly-wheel. In this way the whole of the cocoon can be unwound, except the innermost layer next to the chrysalis. The thread is reeled off on the axle, in skeins of about half a seer at a time. The quantity of silk yielded by the cocoons varies according to the brood. The cold-weather brood gives the least, and is usually reserved for breeding, only the inferior cocoons being spun. The *katia* and *jethua* broods yield the most silk. A thousand cocoons of the *jarua* brood will yield about two chittacks of thread, and of the *katia* or *jethua* brood three or four chittacks.

"Opinions differ as to whether old cocoons can or cannot be reeled. The cultivator does not usually keep his cocoons so long as a year, unless he is accumulating a stock very slowly. But it would seem that reeling is practicable up to two years at least, and that, if carefully kept, cocoons of even four or five years old can be reeled, and will give silk in no respect inferior to that yielded by fresh cocoons. This experiment, however, is one which is not often made.

"No part of the *muga* cocoon is rejected as useless ; the floss plucked off before reeling, the silk of the shell immediately surrounding the chrysalis, and the cocoons kept for breeding, after the moth has forced its way through them, though unfit for reeling, are spun by the hand into a coarser kind of thread, called 'waste' or *era*, which is used for mixing with *eri* thread, or is woven by itself into rough but warm and durable fabrics.

"The price of *muga* thread varies according to quality, from R8 to R12 per

seer. The latter is the ordinary rate in Sibsagar bazar at present (1884). In 1876 I find the price quoted as ₹7. Waste *muga* thread can be bought for ₹4 the seer.

"The cloth woven from *muga* yarn has a bright yellow colour and a pretty gloss. It stands washing much better than other silks, keeping gloss and colour to the last. It is usually sold in pieces about five yards long by four feet broad, and the price varies from ₹1-8 to ₹2 per square yard. . . . . *Muga* is less widely spread than *eri*, and the annual outturn is probably less; but there are no means of estimating its amount. The outturn of the Sibsagar district is supposed to be 205 cwt. (280 maunds) of silk (only half the leased *sum* lands being assumed as actually under *muga* cultivation), that of Darrang is shown as 8 cwt. (11 maunds), and of Kamrup as 15 cwt.) (20 maunds), though Darrang produces more than Kamrup; but these estimates are quite untrustworthy. Sibsagar is the great *muga*-growing district of the Assam Valley; next to that, the south-western portion of the Mangaldai subdivision, and the western part of Kamrup to the south of the Brahmaputra, where the Rani mauza especially is celebrated for supplying breeding cocoons to Upper Assam. *Muga*-breeding is also carried on to a considerable extent in the closely-populated tract in the centre of the Kamrup district north of the Brahmaputra. There is a good deal of *muga* cultivation in Lakhimpur, where the *sum* tree grows wild in great profusion, and the worms are reared on a large scale in forest areas from which the undergrowth has been cleared, the cultivators making their temporary homes in these spaces until the breeding season is over. The more closely peopled mauzas of Nowgong also contribute largely to the stock of *muga* in the province. The worm seems to be unknown in Sylhet and Cachar, while the hill districts do not produce the trees on which it feeds. . . .

"An account of *muga* silk would not be complete without a few words on the two varieties assumed by it when the worm is fed on the *champa* (or more properly *chapa*) and the *mezankuri* or *adakuri* (*Tetranthera polyantha*). *Champa* silk seems to be quite forgotten now. It is described as a very fine white silk, which used to be worn only by the Ahom kings and their nobles. *Mezankuri* silk is still to be procured, but with great difficulty. In 1881 there does not seem to have been a single piece obtainable in Jorhat. One of the reasons alleged for this falling off is that the new rules restricting clearances in the forests are unfavourable to the growth of the *mezankuri* tree. This tree springs up spontaneously in abandoned clearances, and it is in this early shrub-like stage that it is fit for the worms to feed on. In its second year the worms fed on it give coarser silk; in the third year the silk is hardly distinguishable from the common *muga*. Thus the mature tree is quite out of the question, and as the *mezankuri* is never cultivated, forest clearances were the only places where the breeders could look for young trees. When fed on the *mezankuri*, the *muga* worm spins a fine silk of almost pure white, about thrice as valuable as the common *muga*—in fact the most costly of all the silks of Assam. The thread was selling at Rs. 24 the seer in Jorhat in 1883. This silk is altogether an article of luxury. . . .

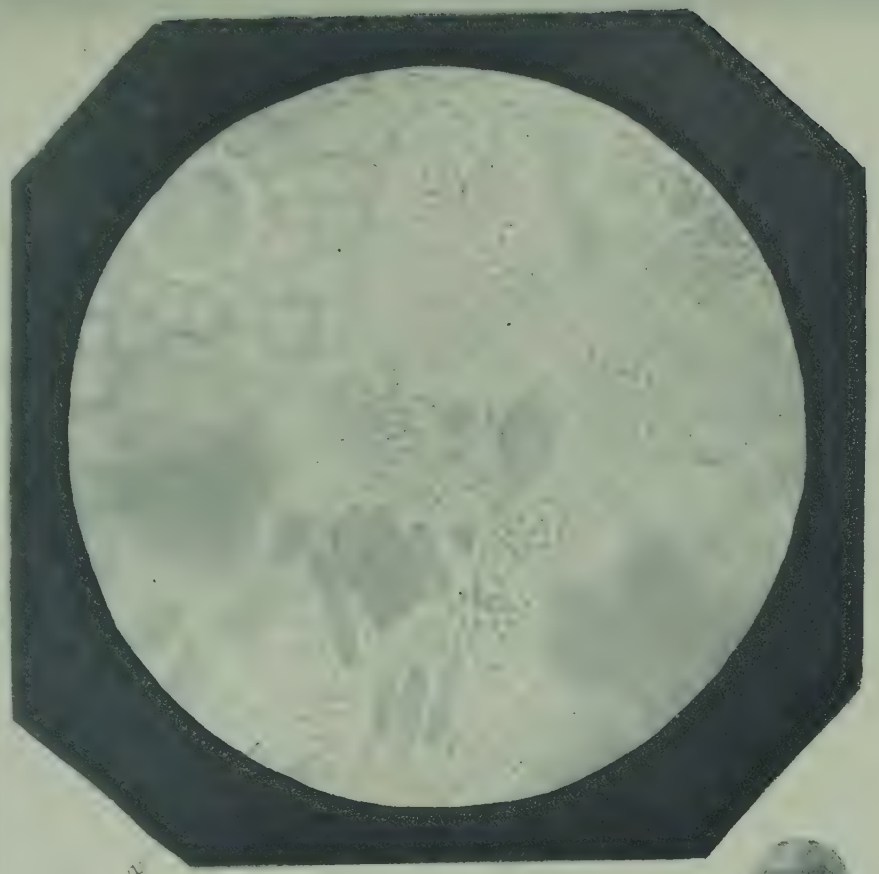
"The *ban muga*, or the forest *muga*, is simply the common *muga* worm in its wild state. The cocoons are not plentiful enough to be largely used, but the wild moth is sometimes allowed (like the wild buffalo) to improve the strain of the domestic breed. Female moths of the domesticated *muga* species, if left outside the house in the evening, will be visited by any wild male moths that happen to be in the vicinity. The silk of the *ban muga* is occasionally mixed with *eri* by the Cacharis."

ERI.
Attacus ricini. BOISD.

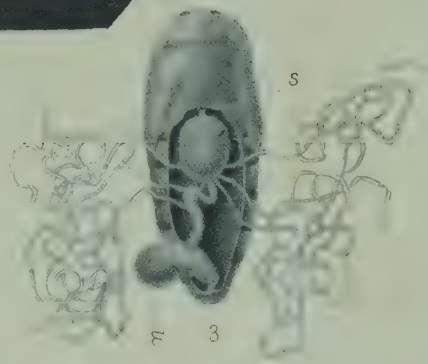
Bombyx mori, LINN.
after Maillot.

DESI
Bombyx fortunatus. HUTTON

Photo-etching from the original pencil Drawings Survey of India Offices Calcutta, January 1890



Portion of the interior of the stomach of a chrysalis of BOMBYX MORI suffering from FLACHERIE, showing chain ferment a, besides portions of leaves, tracheae &c. (after Pasteur)



Chrysalis of BOMBYX MORI with dorsal portion of the integument removed, showing the stomach s exposed for removal for microscopic examination (in FLACHERIE (after Pasteur

Corpuscles from the tissues of an insect attacked by FEBRINE magnified 370 diameters (after Pasteur

PLATE V

TUSSER
Antheraea mylitta, Drury.

Photo-etching from the original pencil Drawings Survey of India Offices, Calcutta, January 1890.

MUGA

Antheraea assama, Westw.

Photo etching from the original pencil Drawings Survey of India Offices, Calcutta, January 1890.

NOTICE.

THE serial *Indian Museum Notes* is issued by the Trustees of the Indian Museum, Calcutta, under the authority of the Government of India, Revenue and Agricultural Department. It is chiefly intended to record information on the subject of the Economic Entomology of India, and thus gradually to furnish materials upon which to base a comprehensive knowledge of this important subject, which has hitherto been but little studied. For the views expressed the authors of the respective *notes* are alone responsible.

The parts of the serial will be published from time to time as materials accumulate. Communications are invited; they should be written on one side only of the paper and addressed to—

The Editor,
Indian Museum Notes,
Calcutta.

Correspondence connected with Economic Entomology should be accompanied by specimens of the insects to which reference is made. Caterpillars, grubs, and other soft-bodied insects can be sent in alcohol; chrysalids and cocoons, alive, and packed lightly in leaves or grass; other insects, dried and pinned or wrapped in soft paper. Live insects should be sent when there is a reasonable probability of their surviving the journey. Caterpillars, grubs, and other immature insects can often be only approximately determined; they should therefore, where possible, be accompanied by specimens of the mature insects into which they transform; when, however, this is not possible, they should still be sent, as they can always be determined approximately, and uncertainty must necessarily arise in discussing insects when actual reference to the specimens cannot be made.

Insects forwarded for determination should in all cases be accompanied by a detailed report showing precisely in what their Economic importance consists.

THE EDITOR.

INDIAN MUSEUM,
9th January 1890.

NOTES ON INDIAN ECONOMIC ENTOMOLOGY.

RHYNCHOTA.

BY

E. T. ATKINSON, B.A., C.S., C.I.E.

MOSQUITO BLIGHT.

In this paper, reference is made principally to the species of the genus *Helopeltis* of the family *Capsidæ*, belonging to the sub-order Hemiptera-Heteroptera of the Rhynchota. The genus comprises the insects so well known as the 'mosquito blight' in Assam and Sikkim, as the 'roest' or 'rust' in Java, and under similar names wherever the tea plant is cultivated. Species of this genus have been reported from the Philippine Islands, Java, the Eastern Archipelago, Ceylon and India, and are of considerable economical interest from the ravages that they commit. It was my intention to prepare a monograph of the entire genus, but this could only be done with fresh materials, and it appears to be desirable to summarise here what is known regarding the genus, and ask those interested to forward fresh specimens in weak alcohol for a fuller description of the species.

Genus HELOPELTIS, *Signoret.*

Ann. Soc. Ent. France (3 s.), vi, p. 502 (1858).

First joint of the antennæ as long as the head and the pronotum taken together, second joint longest, 3—4 joints short: scutellum with a spine on the disc: sides of the abdomen reaching beyond the hemelytra. Signoret placed this genus in the subdivision 'unicellules,' formed to contain those genera in which the membrane has but a single cellule, the head transverse and truncate beyond the eyes, the antennæ long and slender, ocelli wanting, and the pronotum narrowed anteriorly. The division to which *Helopeltis* apparently belongs is represented in Central America by Distant's '*Valdasaria*' (Biol. Cen. Am. Hem., p. 242).

Helopeltis antonii, Signoret.

Plate XII, fig. 5.

Helopeltis Antonii, Signoret, A. S. E. F. (3 s.), vi, p. 502, t. 12, II, f 2 (1858); Walker, Cat. Het. vi, p. 165 (1873): Waterhouse, Proc. Ent. Soc., p. xxvii (1885); *id.*, Trans. Ent. Soc., p. 458, t. 11, f. 5, 5*a* (1886).

Black varied with red: head black, rostrum yellowish: antennæ black, yellow at the base: pronotum and pectus sanguineous: scutellum red, spine yellow, cup-shaped at the apex: hemelytra brown-yellowish, deeper at the base than at the apex, median portion transparent: abdomen yellow, with a basal spot and apex, black: feet black: femora nodulose, the first pair with a yellow ring at the base, intermediate pair of a lighter colour, varied with yellow; last pair with a yellow ring at the apex (*Sign.*). Long, 11; broad, 2 mill.

Waterhouse describes (*l. c.*) specimens received by him from Ceylon:— "Black: pronotum red, with a blackish line in the anterior constriction: scutellum blackish, inclined to red at the sides: the spine on the scutellum perpendicular, straight, yellowish: antennæ brown, the extreme base testaceous: legs sordid yellow, speckled with brown." He suggests that his description refers to ♀ only, as the ♂ would probably have the pronotum black.

Reported from Ceylon. Dr. Trimen, in *Nature* for October 23, and December 25, 1884 (Vol. xxxi, p. 172), remarks that this species is found on the cacao and is its only formidable enemy. In the same Journal for October 30, 1884, Mr. W. L. Distant states that he had received from Ceylon mutilated specimens of a Reduviid which doubtless occurred with the Capsid *H. Antonii*, easily known by its nodulose femora and the spine on the scutellum. The Reduviid, however, probably feeds on the Capsid, and from its similar form and size may be confounded with the really injurious insect, so that in taking measures against these pests the Reduviid should be spared.

Helopeltis bradyi, Waterhouse.

Helopeltis Bradyi, Waterh., Trans. Ent. Soc., p. 458, t. 11, f. 1, 2 (1886).

♀ Black: pronotum deep red, with the anterior margin black: scutellum reddish-yellow, the horn perpendicular, straight, black at the base: antennæ black, extreme base testaceous: legs black, a pale-yellow ring at the base of the femora; tibiæ brownish: sides of the basal segments of the abdomen clear yellow as in *H. antonii*, Sign. Long about 5½ mill. (?).

♂ The pronotum and scutellum black; spine on scutellum a little brown at the base: sides of the abdomen with less yellow (*Waterh.*).

Mr. Waterhouse observes that this species appears to average a trifle larger than *H. antonii*, and the ♀ is a little broader. Signoret gives 11 mill. as the length of *H. antonii*, so that the length of this species is probably 11½ mill., not 5½ mill. as printed in the description. Mr. Waterhouse obtained this species from Java, where it was reported to have done much mischief on the Cinchona plantations.

Helopeltis niger, Walker.

Helopeltis niger, Walker, Cat. Het. vi, p. 165 (1873); Waterhouse, Trans. Ent. Soc., p. 459, t. 11, f. 6 (1886).

Dulichius? clavifer, Walker, *l. c.*, iv, p. 170 (1871). New Guinea.

♂ Black, slender, shining, nearly linear: head small, short: eyes very prominent: rostrum reaching the intermediate coxæ: antennæ very slender, over twice as long as the body, first joint, rather shorter than the body, second much longer than the first (dark brown, the basal joint yellowish brown): pronotum anteriorly contracted where there is a transverse furrow: scutellum with a long filiform capitate appendage: legs long, slender (pale brown, with a few darker spots on the femora): wings blackish, slightly hyaline (*Walker*). Long. 5¼ mill. Reported from New Guinea, Waigiou.

Walker notices a variety, probably the ♀, which has the pronotum red, black along the fore border, and the hind femora blackish. Long, 8⅓ mill. Waterhouse notes that the scutellar spine is long, very slightly curved; light brown, with the extreme base and apex black.

Helopeltis braconiformis, Walker.

Helopeltis braconiformis, Walker, Cat. Het. vi, p. 165 (1873); Waterhouse, Proc. Ent. Soc., p. xxvii (1885); *id.*, Trans. Ent. Soc., p. 459, t. 11, f. 4 (1886).

♀ Black, slender, smooth, shining: head transverse, very short: eyes prominent: rostrum reaching the last coxæ, first joint reddish: antennæ very slender, much longer than the body, first joint subclavate, second much longer than the first, third a little shorter than the first: pronotum and scutellum red, the latter with a slender, erect, black, capitate spine: abdomen whitish at the base, legs reddish, long, slender: femora slightly nodulose, black towards the apex, and with two black bands: hemelytra blackish, whitish at the base, extending much beyond the abdomen (*Walker*). Long, 6⅓ mill.

Reported from New Guinea.

Waterhouse describes both sexes:—♂ Black or nearly so: antennæ brown, with the basal joint pale brown: base of pronotum smoky brown: scutellar spine long, very slightly curved, very pale brown, with the extreme base and apex dark brown: legs pale brownish-yellow, with a few dusky spots on the femora.

♀ Antennæ dark brown: pronotum light red, inclined to yellow in front, with the anterior margin black: scutellum pale red, the spine very pale brown: legs dark brown, some spots on the femora and the tibiæ paler, but not so pale as in the ♂. Differs from preceding in the form of the scutellar spine and the colour of the legs and the antennæ.

Helopeltis febriculosa, Bergroth.

Ent. Mon. Mag., xxv, 1889, p. 271.

?=*H. theivora*.

♀ Black, variegated yellowish, oblong, shining; hemelytra subcinereous; scutellar horn somewhat straight.

Head black, marked with a luteous, lateral, longitudinal streak continued to below the eyes; first joint of the antennæ extending a little beyond the apex of the scutellum, sordid piceous; second joint nearly one half longer than the first, linear, black, very slightly somewhat capitulately thickened at the apex: rostrum nearly reaching beyond the last pair of feet, luteous, here and there picescent, sparingly thinly pilose, especially towards the apex, second joint a little longer than the first, third joint shorter than the second, fourth longer than the third: thorax above luteous-yellow, with a transverse basal band, more extended forward in the middle, and a transverse streak placed a little before the apex, black: scutellum black, marked on both sides at the base of the horn with a lutescent spot, the scutellar horn as long as the thorax, erect, only very slightly curved, black, picescent near the apex, which is horizontally truncate: femora nodulose, piceous-luteous, sprinkled black, first pair, near the base, with a pale-yellowish ring: tibiæ clothed with slight, somewhat hispid, pile, luteous, spotted black: tarsi black: basal part of abdomen sub-virescent, whitish, apical part black, the pale colour of the venter extends from the base to the apex of the penultimate ventral segment, the last ventral segment and the genitalia are black; the black colour of the dorsum of the abdomen is more extended towards the base especially in the middle of the segments: hemelytra cinereous-hyaline, except the base, which is yellow whitish: veins and the narrow cuneus, piceous: wings cinerescent. Long, 5mill.; cum hemel, 8 m. Hab. Sikkim.

This species was found amongst a number of *Disphinctus humeralis*, Walker, sent by me to Dr. Bergroth for identification. All were collected on the Cinchona plantations at Mungphu in Sikkim by Mr. Gammie, where this species was found on *Cinchona calisaya*, and occasionally on *Cinchona succirubra*. It has not occurred yet in sufficient numbers to do much damage; but as it belongs to the same genus as the destructive 'Mosquito pest' of the tea, its operations should be carefully watched. *H. febriculosa* is allied to *H. theivora*, Waterh., but is distinguished by the erect, very little curved scutellar horn; in *H. theivora*, ♀, the horn is much curved: this difference, however, appears to be merely of varietal importance.

Helopeltis pellucida, Stål.

Plate XII, fig. 4.

Helopeltis pellucida, Stål, Ofvers. K. V.-A., Förh., p. 667 (1870).

♀ Black, shining, levigate: rostrum, first joint of the antennæ near the base, tylus, streak on head below the eyes and base of collum: scutellum, abdomen before the middle, and the feet, flavescent: first femora above more obscure, intermediate pair infuscate at the base, and in the middle: hemelytra sordid hyaline, veins fuscous: joints of rostrum

infuscate in the middle (*Stål.*). Long with hem., 8½; broad, 2 mill. Reported from the Philippines.

Helopeltis collaris, Stål.

Plate XII, fig. 3.

Helopeltis collaris, Stål, Ofvers. K. V.-A., Förh., p. 667 (1870).

♀ Black, shining: pronotum flavescent, anterior band and transverse basal spot black: first joint of antennæ, scutellar spine in the middle, rostrum and the feet, sordid testaceous flavescent: femora obsoletely spotted fuscous: hemelytra very palely fuscous hyaline, veins fuscous: clavus towards the base, pale sordid flavescent: abdomen before the middle, yellow-testaceous: joints of rostrum infuscate in the middle (*Stål.*). Long, 8; broad, 1⅔ mill. Reported from the Philippines.

Helopeltis podagrica, Costa.

Aspicelus podagricus, Costa, Ann. Mus. Zool. Nap. ii, p. 147, t. 2, f. 6: Walker, Cat. Het. vi, p. 165 (1873).

Brunneous-rufescent, shining: hemelytra with the corium amber virescent-hyaline, costa and appendage brunneous, membrane irideous, veins fuscous: antennæ 1½ time as long as the body with the hemelytra, first joint as long as the head: pronotum and scutellum slightly incrassate towards the apex; the rest filiform; second as long as the first, third shortest of all, fourth a little longer than the second: rostrum reaching the intermediate coxæ: pronotum rather convex, inclined and narrowed anteriorly so as to form a rather distinct neck: scutellum somewhat semi-circular, posteriorly truncately rounded, slightly notched in the middle; the disc is elevated in a cone and prolonged in an elevated vertical spine, a little arcuate, as long as the head and pronotum, and ending in a cup-shaped knob: hemelytra fine, semi-transparent: feet long, almost of equal length: femora a little incrassate, somewhat arcuate, nodose. The general colour is shining russet brown; membrane iridescent with fuscous veins. Long with hem., 7½; antennæ long, 12 mill.

The habitat is not recorded.

Helopeltis romundei, Waterhouse.

Trans. Ent. Soc., p. 207 (1888).

♂ Black, shining: legs pale sordid yellowish, mottled with light brown: scutellar spine pale sordid brown, pale yellow at the base, formed as in *H. bradyi*, very little curved, slender: abdomen with a narrow line of yellow at the sides of the basal segments: legs much paler than in *H. bradyi*.

♀ Pronotum red, with a dusky line near the front margin: scutellar spine longer than in the ♂, and distinctly curved, a character in which

it differs from both *H. bradyi* and *H. antonii:* abdomen with more yellow at the sides: rest as in ♂.

Hab. Java: on tea.

Helopeltis theivora, Waterhouse.

Plate XII, fig. 2.

Helopeltis theiovora, ? Moore, Wood-Mason, Tea-bug of Assam, p. 12 (1884): Proc. Agri. Hort. Soc. Calc., 20 Nov. 1873, and v, p. xviii, xxviii (1878); Westwood, Gardener's Chronicle, Feb. 21, 1874.

Helopeltis theivora, Waterhouse, Trans. Ent. Soc., p. 458, t. xi, f. 3 (1886).

♀ Black: pronotum orange-yellow, with a black line near the anterior margin, the base margined with black: scutellum brown, black at the base, spine or horn long, much curved, black, at the apex brown: antennæ dark brown, basal joint paler, yellow at the base: femora dark brown, mottled with light brown, with a light-yellow ring at the base: tibiæ light brown, speckled with dark brown (*Waterh.*).

Reported from Assam, Sikkim.

Easily recognised by the long and curved spine on the scutellum Mr. Moore does not appear to have described this species, so that Mr. Waterhouse must be considered as having named it.

There does not appear to be any fixed time for the appearance of the insect or seasonal broods. The eggs are found apparently both in the axils of the young buds and on the lower leaves, but this is a point requiring further examination. The larva is about $\frac{1}{16}$ inch long, obtuse, soft, with a very small, clavate caudal appendage; colour amber-hyaline, but after sucking the juices of the green leaf for some time it becomes of a greenish colour. The head is horizontal; the rostrum is about one third to three eighths of the length of the body, and in repose lies quiescent on the pectus: two eyes, no ocelli: antennæ purplish, hemelytra rudimentary: gradually the insect increases in size and becomes of a deeper amber or orange colour, the antennæ become longer and turn to black, and the insect is less active, though furnished with complete hemelytra, which with the head and pronotum is black, whilst there is a broad white band on the abdomen.

An observer informs us that the insects seem to commence tapping in February and go on till the end of August. A young larva procured by nipping off the shoot, a leaf or two below the place where it was seen, was placed in a bottle with a shoot containing a pekoe bud and leaf and a pekoe-souchong leaf. After 21½ hours it was found that this single insect had made 58 taps on the pekoe-bud, each marked by a discoloration of the epidermis: there were 48 marks on the pekoe-leaf and 18 on the pekoe-souchong leaf. The spots at first were of a brown olour, but soon changed to black. Dr. Aleyboom states that these

insects, in Java, repose during the day near streams and in moist ground, and feed by night, though a few may be found during the day in shady positions on the shrubs, but not on the ground. The garden referred to was surrounded by paddy-fields and near a river, and seemed to be more liable to attacks in cold and wet weather. The insects in Assam are to be found to repose in shady positions beneath the shrubs, and do not leave the area attacked. The observations of Dr. Aleyboom would therefore appear to be not of general application, but to have reference to the particular position of the garden referred to.

H. theivora is the form with which we are chiefly concerned in India, and Mr. S. E. Peal of Sibságar was the first to bring to notice (Journ. Agri.-Hort. Soc., Calcutta, IV (i), p. 126, 1873) that the "black blight," "smut," &c., on tea was the work of this insect and not a spontaneous fungoid growth. Further investigations have shown that the attacks of these insects occur under all conditions of soil and climate, in high land and low, dry or wet, rich or poor, in a dry season as bad as in a wet one, and as frequently with good culture and clean tea as with the reverse. That it is not due to "shade" or "want of cultivation" is shown by the fact that in the two worst cases, one had the garden particularly open, and in the other it was quite clean. It is difficult from one year's attack to say where the insect will appear the next year: all places appear to be equally liable to its ravages, but it seldom is seen over an entire garden at once.

Diagnosis.

Mr. Peal states that the young leaf alone is first attacked, and the more tender and succulent the shoots are, the more they suffer. The shrubs show the shoots brown and withered in a garden that has for some time felt the attacks of the insect; but if only recently attacked, the general appearance is normal, and only on the youngest shoots and twigs are a few small brown spots seen, the size of the spots varying with the age of the insect causing them. If the insect be very young, the punctures are minute and close, and the consequent discolorations coalesce and become continuous. When the larva attains its full growth, these spots become one eighth of an inch in diameter. When the punctures are recent, the colour is pale brown and darkest at the edges; but if one or two days old, the spots are dark brown, verging on black, the entire leaf curling up and withering completely if they be at all close. Where the shrub has suffered for some time and severely, the symptoms are often less visible at first sight. The dead leaves have for the most part fallen off and the minute shoots at the leaf-axils above show the damage, all being dried and dead; there is less dead leaf showing, but dead "tips" appear everywhere. Further examination will show that the affected shrub, ere it ceased entirely to shoot out, had made many efforts to

grow, all of which had proved abortive, and a branch that has not yielded a single leaf presents all the appearance of having been very severely plucked. On the tips of the young vigorous shoot being punctured and its juices withdrawn by this insect, it has died as certainly as if nipped off. When the eyes below the leaf-axil shoot out, and before the insect can do serious damage, one or two shoots may attain some size and bear several leaves, but as the insect increases in size, these tips are attacked; other shoots start from other eyes, attaining, however, a less vigorous growth; these too, in a short time, succumb, and the shrub becomes leafless. When this occurs growth ceases, as every shoot requires from 40 to 50 days to mature so as to be fit for plucking, and the recovery of the tea is slow unless pruned.

Dr. C. Aleyboom of Java in the same Journal (v (i), p. 55, 1878) describes the attacks of this insect on the tea-shrub there much in the same manner, except that he states that it attacks the under side of the leaf. He adds that the insect inserts its rostrum and remains for a long time on the same spot, and some hours afterwards the leaf shows a brown puncture that slowly turns black on the very spot where the puncture has been made. If the leaf be punctured closely it becomes black and so dry that it can be pulverised by rubbing between the fingers, and examination shows that the insect has removed all the juices from the soft part of the leaf. As in Assam, so in Java, the insect attacks first the buds and then the young leaves, and last of all the old thick leaves, until the shrub becomes leafless, and to prune it in this state is hurtful. The denuded shrubs seldom make new shoots, for the insects after having destroyed the leaves return to the parts of the twigs where the juices are gathering to send forth new shoots, and by sucking the juices there effectually prevent the development of buds. By remaining leafless the bark whitens and the wood becomes dry, and if the attacks continue for two consecutive years, the branches become covered with moss and die.

As already stated, these insects are reported in Assam to occur in all sorts of soils and under all atmospheric conditions. In Java, too, Dr. Aleyboom's researches have led to a similar result. There the soils may be divided into two classes—(*a*) those containing humus, and (*b*) those composed of red clay. "The first series comprise a mechanical admixture of humus, clay, and sand; it has a black hue, sometimes a depth of eight feet, and, when heated, it becomes red from the presence of oxide of iron, and gives off an ammoniacal odour. There are several varieties, due to the varying proportions of the constituent parts, but they usually contain mineral substances and from eight to twenty per cent. of humus. The humus soils absorb and preserve moisture, and old shrubs usually thrive on them and produce a rich foliage. Young plants, however, easily fade and perish, and seeds do not develop, but rot.

The clay soils are of a brown hue, and are usually composed of fine clay and from ten to fifteen per cent. of the oxide of iron, with some proportion of sand. These soils are arid, and during the rains absorb much water, drying up to the depth of two or three feet immediately afterwards, and also becoming heated. Here the tea-shrubs do not thrive except in moist seasons.

From 1869 to 1873, the shrubs in the humus soils were always affected by blight, which first attacked the leaves and the best-developed shrubs in the best parts of the garden, also the shrubs in the alluvial portion lying at the base of or between the hills. The shrubs in the red soils were at first free from blight, but they were also attacked when the fine leaves on the shrubs in the humus soils had been destroyed. Several experiments were then undertaken in order to ascertain the cause. Where the humus was thin or absent, the roots of the shrubs were top-dressed with good earth, which led to a new flush that was again attacked and destroyed by the blight. A very fertile part of the plantation was dug to a depth of 18 inches and thoroughly cleaned; in another place, furrows to the same depth were made and filled with branches of other trees; again, another patch was drained; in another sticks smeared with tar and *oleum cornu cervi fœtidum* were placed amongst the shrubs; tar was also put in the ground; but none of these experiments proved successful. Large quantities of *calcium sulfuratum* were also placed on the ground, and in another part freshly-made phosphates, but the rust did not diminish. Fumigation with sulphur burned to windward only resulted in the destruction of the leaves reached by it; whilst fumigation by burning bad-smelling wood and leaves to windward had no influence at all. Pruning only gave temporary relief, and when potatoes were planted in the neighbourhood of affected shrubs, they also blackened and died.

Remedies.

Picking off the insects as they appear has been recommended and tried. When it is considered that if only moderately bad there are ten to twenty insects on each bush, and if very bad thirty to forty, and the shrubs are planted 6′ × 3′, the number of insects to an acre—and therefore the numbers in a considerable garden—will preclude recourse being had to this procedure on an extensive scale. The insects are most injurious in the larval state, even when they are of miscroscopic dimensions, and when disturbed, however slightly, drop through the bush to the ground, where it would be useless to follow them. Picking would therefore be too expensive and unsatisfactory, as only partially clearing the bushes. In this connection Dr. Aleyboom recommends the early plucking of tips and tender leaves, so as to diminish the food-supply of the insects, which, as already noted, attack those parts first. Another suggestion that cannot be recommended is to place bird-limed strings or light cotton bags smeared with some similar sticky substance in the affected areas.

Syringing as a prophylactic would be of little use in the rains, as in a day of heavy rain the substance used would be washed away. Spraying infected tips when the attacks first appear with kerosine emulsion as an insecticide appears to promise good results. It has been of practical value in the case of coccid pests on coffee, and is very simply made. The proper course suggested by the life-history of the insects is to search for the eggs, and to spray those places where they occur, for, as a rule, in the earliest stages, the larvæ are found only where the eggs have been deposited. A useful formula for kerosine emulsion prescribed in America, to be varied according to circumstances and experience, is that given in No. 2 of "*Notes on Economic Entomology*," and which for reference is reproduced here :—

"An emulsion resembling butter can be produced in a few minutes by churning with a force-pump two parts of kerosine and one part of sour-milk, or soap solution, in a pail; emulsions made with soap solutions being generally found to be the more effective. The liquids should be at about blood heat. This emulsion may be diluted with from nine to fifty parts of water, which should be thoroughly mixed with one part of the emulsion.

"The strength of this dilution must vary according to the nature of the insect to be dealt with, as well as to the nature of the plant; but finely sprayed in twelve parts of the water to one of the emulsion, it will kill most insects without injury to the plant."

It should be applied through a spray nozzle—

"The nozzle which best combines the necessary qualities is undoubtedly the eddy or cyclone nozzle, consisting of a small circular chamber with two flat sides, one of them screwed on, so as to be readily removed. Its principal feature consists in the inlet, through which the liquid is forced, being bored tangentially through its wall, so as to cause a rapid whirling or centrifugal motion of the liquid, which issues in a funnel-shaped spray through the central outlet in the adjustable cap. The breadth or height, fineness or coarseness, of the spray depends on certain details in the proportion of the parts, and specially in the central outlet.

"To drive the liquid through the nozzle some kind of force-pump is required, and a great number have at different times been experimented with, some of them being of a most complicated nature. It is perhaps not of any very great consequence which particular form is adopted for use in India; but the aquapult force-pump, which has been arranged to be worked entirely by one man, who also distributes the spray, seems to be about the best suited for general use in a country where economy in labour is generally not so great an object as economy in the cost of apparatus."

Amongst the many remedies proposed, cutting down the forest and grass jungle adjoining plantations has found some favour. A writer in the Calcutta Journal already quoted suggests that *toon* trees may harbour the insect (November 1885), another that spear grass and other similar growths furnish the shelter. There is no doubt that in this country grass harbours vast numbers of *Capsidæ*, and it is quite possible that the original food-plant of the insect may be discovered and eradicated. It is, however, for the planters themselves to discover this, and there can be no harm in removing and burning during the cold weather grass jungle in the neighbourhood of plantations. Some support is given to

this remedy by the statement of a planter that "even if destroyed on the tea plants, the insects come in from the neighhouring jungle, which should be burned down." Others say (Journ., *l. c.*, vii, p. xlii) that clearing the jungle is of no value. There is no precise record, however, in the whole of the correspondence regarding this pest of the presence of the insect on any plant other than tea or cinchona.

Anointing the bushes with "tar" has been recommended and tried, but abandoned, as it flavours the tea. Fumigation by burning bad-smelling weeds is reported in some cases to have kept down the pest, "but to do this successfully, the *tila* surroundings where they harbour and breed must be cleared away and burned during the cold weather."

The following extracts from correspondence bearing on this subject may be of interest. Mr. Driver, while in Assam, had considerable experience of the insect pest known as Mosquito blight, and he gives the following description of it:—

"The young ones generally appear in pairs. They are very small, and hide themselves by running under the leaves or down the stems. They suck the juice from the new shoots, which shew small brown spots whereon punctured.

"If they are allowed to increase to any great extent, all the young shoots dry up and the bushes appear as if their tops had been burnt. I think the eggs are laid at the points where new shoots spring from the older stems, and they are hatched in March, just about the time the new shoots begin to grow. They go on breeding during the rains, but heavy rain washes them off the bushes and destroys them. These insects are indigenous in Assam, and while in the jungles live on a creeper known as the 'Jungly pan.' The jungly pan leaves a taste very like the pan of commerce. The insect is called 'Woohonce' by the Assamese. These insects thrive best under large shady trees, such as the rubber and wild fig.

"To eradicate them the bushes have to be stripped of all their leaves, the ground has to be deep-hoed, and people have to be put on to catch and kill by hand any that appear after that."

Mr. R. B. Walker, Manager, Sookerating Tea Estate, Doom Dooma, Dibrugurh, writes:—

"Now to reply to your inquiries about what we did to get rid of the 'Mosquitoes.' To begin with, before we stopped plucking last year, and while the blight was at its worst (about September and October), I started cutting down a 'belt' of jungle 80 yards wide all round the edge of the garden; this 'belt' was completed about the same time as the pruning of the garden was finished (the end of February this was): well then I commenced lighting fires all over the place; in the tea the prunings were being reduced to ashes as rapidly as the cut-down jungle in the 'belt' was being burnt up; by the middle of March I finished all the burning I wanted to do, and then every soul was put on to hoe round the bushes, *take away all stale earth from near the stumps of the plants, and fill in fresh earth.* The pruning I went in for last cold weather was most severe: the whole of the garden nearly was cut down to within eight inches of the ground; *all* knotty and gnarled wood was removed, and nothing but straight wood left. During the pruning, immediately following up the pruners were gangs of women and children armed with small knives whose only work was to rid the *bushes of every leaf and small twig.* To protect the plants from the flames (while the prunings were being burnt) a drain

fifteen inches deep by a foot wide was made in every alternate row of tea, and into this the pruning *leaves, &c.*, from round about were carefully brushed before being set alight to.

"Up to date not a trace of the blight is to be seen; this time last year about 100 acres (or more) were completely ruined; the tea is looking as healthy and nice, and growth is as vigorous as though the plants had never been blighted. So successful have we been so far in combating this destructive pest, that I am convinced now we will not be troubled with it *at all* this season, and that we will make our 8 to 8½ maunds an acre against a miserable 4 maunds an acre last season!

"The theory of letting tea run has been tried without the slightest signs of doing any good, for the simple reason the bushes *can't* and *won't* run! Bushes that I left alone during the three months (middle of April to middle of July) were, if anything, smaller at end of this period than at commencement of it, because not a vestige of growth had been made during the whole of this time, and the long healthy shoots (chiefly in the very centre, therefore the tallest part of the bush) died gradually down to the parent stem. I have measured some of these dead shoots occasionally and have found them in some cases to be over 18" long.

"The shoots that I have found to so die down have always been of this year's growth, *viz.*, those shooting out from just below last cold-weather pruning.

"Now, as blighted patches here have been found to have a large number of the young of the Bug (which by the bye are in appearance like red ants, with two feelers apiece, and are wingless) in all stages of development (from the size of a pin's point to almost a full-grown bug) on nearly every bush, and as these young live right away inside the bushes and feed on only the 'minute shoots at the leaf-axils,' the theory of pruning is to give the bush pruned a severe check and so stop for a time the rising of sap (and, of course, the production of the 'minute shoots at leaf-axils') in the hopes this brief period of the bushes dormancy will be sufficient to kill the young bugs of starvation. Whether we have succeeded or not in destroying *any* young ones by starvation it would be difficult to say, but that pruning is doing good is quite certain. Three days ago I got 25 maunds of leaf off the piece of tea that was pruned (5 acres in June last) in July; previous to pruning, this bit of tea was *completely* 'shut up' for about 2½ months.

"Of course we know it is only right to cultivate and keep extra clean any tea that may be 'hanging fire' or doing at all badly, I reversed the order of things with a bit of about 5 acres of very badly blighted tea: I allowed it to go into 'howling jungle,' the bushes were out of sight for over a month; strange to say when I hoed and cleaned it up after a fortnight, I found the bushes quite recovered and with a very decent flush on them. The block of tea of which these 5 acres are a part presents a peculiar spectacle with its small piece of bright green healthy tea surrounded by dismal-looking acres and acres.

"Some weeks ago I tried sprinkling kerosine and water (¼ of k. to ¾ of w.) over a piece (about 2 acres) of tea: on two occasions the day the mixture was squirted I found a young dead mosquito, evidently killed by the oil having reached them. I will with pleasure report results of all experiments to you.

"I forgot whether I have mentioned to you the fact of my having found mosquito eggs on the lower and seed-bearing branches more frequently than I have come across them on any other parts of the bush: *always the old* leaves have I found covered with eggs and *never* have I seen an egg on a *young shoot*. I have more than once found eggs on the tea seed itself. To give you some idea of the number of eggs there are knocking about I'll just mention:—I ripped off from a bush near the bungalow all the leaves with eggs on them: on counting the leaves I found I had 1,741. Some of

these were smeared on both sides. This particular bush was about an average one, and was not picked out by me, because I thought it had a larger proportion of egg-leaves than its neighbours.

"Young mosquitoes are very plentiful too; I have picked off more than 70 from one bush.

"On one occasion I pulled a seed-bearing branch off a bush and counted 33 leaves on it; *every* leaf was smeared on *both* sides with eggs, and besides this the main branch itself and the smaller ones too had any quantity of eggs sticking to them This will show you mosquitoes are not very particular where they lay their eggs. This is quite in opposition to what others say about mosquitoes depositing their eggs in the young shoots between pekoe and souchong leaf."

The Mango Homopteron.

Some account was given of the small Homopterous insects found on the mango at p. 4 of No. I of these Notes, and I am now able to give the descriptions of the three species that ordinarily occur:—

Idiocerus niveosparsus, Lethierry.

Plate XII, fig. 6.

Journ. As. Soc. Calc., 1889, p. 252.

♂, ♀. Flavescent, varied fuscous and white: vertex very finely aciculately strigose, infuscate in the middle, with a very minute black point on each side: frons very finely aciculately strigose, yellow: clypeus yellow, with basal spot black: pronotum yellow, irrorated fuscous: scutellum with a triangular spot on both sides at the base, a narrow median streak reaching the middle and there with two minute spots, black: extreme apex white: tegmina shining, greyish yellow, somewhat transparent, veins fuscous, a white interrupted sub-basal band, and a small irregular white spot at apex of corium; the sides with two spots, one median, oblong, the other apical, black, interrupted by a distinct hyaline white space: body with feet beneath, variegated fuscous, unguicala black. Allied to *I. notatus*, Fabr.; differs in the black lateral spots and the lateral hyaline space on the tegmina. Long, 4 mill.

Hab. Saháranpur; Calcutta.

Idiocerus atkinsonii, Lethierry.

Journ. As. Soc. Calc., 1889, p. 252.

♂, ♀. Elongate, flavescent: vertex infuscate in the middle, with a basal spot, and very distinct lateral spot in the middle, black: frons yellow: clypeus yellow, with a small, median, black, longitudinal line and very minute, fuscous, lateral strigæ: pronotum yellow, with a narrow, median, fuscous, longitudinal line, and two anterior black spots: scutellum on both sides at the base, with a triangular black spot, and, in the middle, with a narrow fuscous streak which is dilated posteriorly and anteriorly, and also two fuscous small spots: tegmina somewhat

transparent, veins fuscous, immaculate: body beneath with feet yellow, unguicula fuscous. Long, 5 mill.

Hab. Baliganj, Calcutta.

Idiocerus clypealis, Lethierry.

Journ. As. Soc. Calc., 1889, p. 252.

♂, ♀. Small, flavescent: vertex yellow, or immaculate, or with two small lateral spots (one on each side), black: frons yellow, or immaculate, or with two black, small, median spots: clypeus yellow, always with a narrow median streak, broader at the base: pronotum yellow, immaculate: scutellum yellow, with an obtusely triangular black spot on both sides at the base: tegmina yellow, shining; veins concolorous; the costal veins of a rather lighter yellow, inwards in the middle very narrowly bordered black; body beneath yellow, with a rather large, black lateral spot on the prosternum: feet with unguicula, yellow. Distinguished by the markings of the clypeus. Long, $3\frac{1}{2}$ mill.

Hab. Calcutta.

Cotton Post.

In February last Mr. E. E. Green, of Punduloya, Ceylon, sent me a small Lygaeid which, he states, infests the ripe pod of the cotton, discoloring and caking the cotton. I find it is the *Oxycarenus lugubris*, described some thirty years ago by Motschulsky.

Oxycarenus lugubris, Motschulsky.

Stenogaster lugubris, Motsch., Et. Ent. viii, 1859, p. 108.

Oxycarenus lugubris, Stål., En. Hem., iv, 1874, p. 141.

Elongate-ovate, above depressed, subopaque, black, humeral spot on hemelytra, sides thereof very narrowly coxæ, last tibiæ in the middle and tarsi more or less whitish: head elongate, triangular, closely rugosely punctured: thorax closely and deeply punctured, somewhat convex, anteriorly attenuated, constricted in the middle: scutellum triangular, punctured in rows obliquely: hemelytra complete, subrugulose: abdomen shining, impunctate, last segment in ♂ canaliculate in the middle, first femora clavate, beneath with long spines, last joint of the antennæ subclaviform, second shorter. Long, $1\frac{1}{3}$—$1\frac{3}{5}$; broad, $\frac{1}{2}$—$\frac{3}{5}$″.

Hab. Ceylon

Ceroplastes, *sp.*

Some twigs and leaves of tea from the Kangra Valley were submitted to me for examination through the Museum. The twigs had adhering

to them white ceroid nodules, varying in size from a sweet pea to a field pea and also in shape, but more or less oval at the base where attached to the twig and with the apex blunt or acuminate. The leaves had a number of white powdery minute particles strewn irregularly over the upper surface. The latter represent the larval stages of a Diaspid coccid belonging to the genus *Chionaspis*, named *C. theæ* by Mr. Maskell, and the larger ceroid nodules, a species of the genus *Ceroplastes*, Gray.

Very little is known of the history and habits of the coccids of this group, and it will be useful to state here what we do know. The first Indian species known was found in Madras, and was named *Coccus ceriferus*, by Mr. Anderson.[1] It is next mentioned by Mr. Pearson in Phil. Trans., lxxxiv, 1794, p. 1, and by Fabricius in his Ent. Syst. Suppl., 1798, p. 546, and Syst. Rhyng., 1803, p. 311. In 1830, Dr. Gray[2] formed for this and some other similar South American insects the genus *Ceroplastes*. The female alone is known, and is described by Dr. Gray from his South American specimens as covered with a wax-like, white test, comprising seven plates arranged in two lateral pairs, and a median series consisting of an anterior, a dorsal, and a posterior plate; the nucleus of the six marginal plates is close to the lower edge, that of the dorsal one nearly central.

In 1853, Mr. Westwood[3] notices and figures *Coccus ceriferus*, and an allied species from Brazil. He writes that the female has the body large and nearly globular, composed of a hard solid white waxy matter, but gives no detailed description.

I again find the same insect mentioned in the Proceedings[4] of the Agri-Horticultural Society, Calcutta, as having been sent from Chota-Nágpur by Mr. Peppe in 1875. Mr. Moore examined the insect then, and reported it to be doubtless the *Coccus ceriferus* of Anderson, found on the Mango, Arjun, Pipal and other trees, and now on tea. He further noticed that it is allied to the *pela*[5] of the Chinese (*Ericerus*), and gave the following analysis of the waxy substance of the test :—

"Of a dull opaque, pale-brown colour : the outer test darker and somewhat translucent: moderately hard and brittle; of somewhat pleasant smell. On crushing in a mortar, minute drops of water made their appearance : on heating, it spluttered much owing to the disengagement of steam : at 55° C. (131° F.) it melted to a clear liquid with a slight flaky deposit : 0·5868 gramme burned left an unweighable trace of ash : absolute alcohol dissolves 34 per cent., boiling absolute alcohol leaves 1·02 per cent. of the wax undissolved. As regards alcohol, therefore, the wax behaves as follows :—Soluble in cold alcohol, 34·00: soluble in boiling alcohol, 64·98 : insoluble in alcohol, 1·02. In either the wax dissolves freely but not entirely : in essence of turpentine it is very

[1] Monograph of *Coccus ceriferus*, Madras, 1791.
[2] Spicilegia Zoologica, 1830, p. 7.
[3] Gardener's Chronicle for July 30, 1853, p. 484.
[4] 18th March 1875, p. vii ; 24th February 1876, p. xii.
[5] Signoret, Ann. Soc. Ent. Fr. (5 s.), iv, 1874, p. 91.

sparingly soluble : carbonic sulphide also dissolves it only partially. The amount of water varies considerably from 11 to 13 per cent. : specific gravity, 1·04.

"Organic analysis shows—

	I	II
Carbon	78·57	78·79
Hydrogen	13·46	13·08
Oxygen	7·97	8·13
	100·00	100·00

which shows it to be a compound having 13 atoms carbon, 26 atoms hydrogen, and 1 atom oxygen."

Signoret,[1] in his paper on the Coccidæ, merely quotes the imperfect description of Anderson, and gives no details. Under these circumstances I have sent examples to Mr. W. Maskell for description, as I have not leisure to take the work up myself. I do not think that there is any danger of this insect doing much damage to tea. If it does become troublesome, the application of kerosine emulsion by spraying to the leaves containing the larva will quickly destroy them and prevent their spreading. The waxy portion of the adult female may possibly be used as an article of trade like the insect-wax of the *pela* in China, but of the uses of the Indian wax we know nothing yet.

[1] Signoret, *l. c.* (5 s.), ii, 1872, p. 40, t. 7, f. 3 ; Atkinson, Jl. As. Soc. Calc., iv (2), 1886, p. 279.

NEW SPECIES OF INDIAN DIPTERA.

BY

MONS. J. M. F. BIGOT.

PHORA CLEGHORNI.[1]

Long = 3 millim.

♀? *Antennis castaneo pallido; palpis, sat dilatatis, pallidè flavidis et nigro circum longe setosis; capite castaneo-nigro longe nigro setoso; haustello porrecto, rigido, pallidè flavido, apice, fusco, capite parum, longiore; corpore pallidè flavido, tergo castaneo, pallido flavido angustissimè bilineato; scutello custaneo; segmentis abdominis, superné latè fusco-obscuro limbatis, limbis graduatim, postice decrescentibus et pallescentibus; pedibus pallidè flavidis, coxis, femoribus tibiisque, externè, angustissimè fusco-nigro marginatis, tarsis apice fuscescentibus; alis hyalinis, venis duabus externis nigris, parum incrassatis, secundà æpice bifidâ.*

♀? Antennes d'un brun roussâtre, chète noirâtre, paraissant glabre; palpes, assez élargis, d'un jaunâtre très pâle, bordés de longues soies rigides et noires; pipette, dirigée en avant, rigide, un peu plus longue que l'axe de la tête, jaunâtre à pointe brune; tout le corps d'un jaunâtre fort pâle, excepté le *tergum* d'un chatain roussâtre avec deux lignes jaunâtres très fines et peu distinctes; écusson de même couleur que le *tergum*; sur chaque segment de l'abdomen une large bande transversale noirâtre, n'atteignant pas les bords, ces bandes décroissent progressivement, de la base à l'extrémité, en dimensions et en couleur; pieds d'un jaunâtre très pâle; *tibiæ* non ciliés, avec quelques épines noires à l'extrémité; hanches *femora* (les intermédiares et les postérieurs un peu dilatés), et *tibiæ* marqués, au bord externe, d'un ligne noirâtre très fine, tarses un peu brunâtrés, ailes hyalines, à peine aussi longues que l'abdomen, brièvement ciliés extérieurement depuis la base jusques vers le milieu, les nervures postales, premières et deuxièmes longitudinales, légèrement épaissies et

[1] Parasitic on the Bengal silk-worm fly *Trycolyga bombycis*, Becher. The specimens were furnished by Mr. C. Marshall of Berhampore (see page 87 of No. 2 of these *Notes*).

noirâtres (la deuxième bifurquée à son extrémité), les autres pâles, nullement courbées à leur origine; organes génitaux un peu brunâtres à leur extrémité.

Cette espèce ressemble assez à la *Phora sinensis* (Schiner, Reise der Novara, Zool. Dipt., *p. 224*), mais la description donné par l'auteur n'est pas assez complète pour qu'on puisse l'identifier surement; elle m'a parue appartenir au sexe féminine et *sans aucun doute*, au genre *Phora* (Latr. Schiner, Macq. Rondani) proprement dit.

Sa larve, longue de 6 ou 7 millimètres, parait divisée en 9 ou 10 anneaux? elle est grêle, cylindröide, acuminée à son extrémité antérieure, et porte, vers l'autre, quelques rares saillies épineuses peu distinctes, sa couleur est jaunâtre.

Indoustan, Murshidabad—3 specimens (conservés dans l'alcool). Je la dédié à Monsieur Cleghorn, qui l'a découvert.

Nota.—Les meurs connues des *Phoras* sont parasitaires, aux dépens d'autres insectes vivants ou morts, voire même de certains mollusques terricoles (v. Dufour).

Rivellia persicæ.[1]

Le diptère, dont suit la description, appartient certainement au groupe des Ortalidinæ en raison de la nervation alaire. Il me semble identique au genre *Rivellia*, Desv. Suivant en cela la classification de Rondani (Bull. del Soc. Entom. Ital. Firenze, 1869): il doit être compris dans le grand genre *Dacus* (Fabricius) v. Macquart. Dipt. d'Europe et Exotique.

Les specimens communiqués (♂ et ♀) était fortement comprimés et desséchés de telle façon que leur description manquera peut-être d'une suffisante exactitude. L'espèce, d'ailleurs, me parait inédite, et je propose pour elle le nom de *Rivellia persicæ.* ♂ et ♀ long=7 mill. (præter oviductum). Antennes, fauves avec l'extrémité noirâtre, palpes, d'un fauve pâle; face et front rougeâtres, la première orneé de deux points latéraux, noires; deux lignes blanches au bord interne des orbites; clypeus rougeâtre avec deux larges bandes longitudinales, peu distinctes, d'un duvet pruineux gris, epaules, deux lignes latérales étroites, d'une blanc jaunâtre: écuisson d'un gris jaunâtre; abdomen roussâtre, avec une ligue dorsale étroite, noirâtre, peu distincte antérieurement; oviduct, court, déprimé, tronqué à son extrémité, jaunâtre; balanciers d'un blanc jaunâtre à massue brunâtre; pieds d'un jaunâtre pâle, les tibiæ postérieurs brunâtres à la base ainsi qu'à l'extrémité, tarses blanchâtres; ailes hyalines, les nervures longitudinales teintées de jaunâtre à la base, et le stigmate d'un jaunâtre très pâle, l'aile est marquée d'une petite mouche noirâtre située à l'extrémité, entre les nervures *costales* et la troisième nervure longitudinale de Rondani.

[1] Destructive to peaches in Chota Nagpur—see p. 195.

A BUTTERFLY DESTRUCTIVE TO FRUIT.

BY

L. DE NICÉVILLE, F.E.S., C.M.Z.S.

Virachola isocrates, Fabricius.

Plate XII, fig. 1*a*, male imago; 1*b*, female imago; 1*d*, back (or dorsal) view of full-grown larva; 1*e*, side (or lateral) view of same; 1*c*, pupa within pomegranate fruit in natural position—all from Calcutta specimens and natural size.

No reports have, as far as I am aware, been received regarding any damage to fruit caused by this insect, though under certain circumstances were this pest to become plentiful, an immense amount of loss might be incurred. It attacks the Loquot (*Eriobotrya japonica*, Lindl.), Guava (*Pridium guava*, Raddi), Pomegranate (*Punica granatum*), and a wild fruit of the Natural Order *Rubiaceæ* (*Randia dumetorum*, Lamk.).

Virachola isocrates, Fabricius, is a butterfly of the family *Lycænidæ*, of the suborder *Rhopalocera*, of the order *Lepidoptera*. It is found almost throughout the plains of India (except the desert tracts), and in Ceylon, but not in Assam or Burma. The insect measures from an inch and a half to two inches with fully expanded wings; the female is considerably larger than the male. On the upper side the male is dull purple in some lights, but brilliantly shot with iridescent violet in other lights. The female is still duller purple above with no violet shot, with a patch of yellow in the middle of the fore-wing, and a black spot crowned with yellow on the margin in the hind-wing. Both sexes are grey on the under side, with a medial band of darker spots across both wings, and a short thread-like tail and a lobe at the anal angle of the hind-wing.

When the fruit-trees which are attacked by this insect are in bloom, the female butterfly may be observed rapidly flying amongst the branches, but occasionally settling on a flower, within the calyx of which she deposits an egg. When the egg hatches, the young larva in all probability at once bores into the heart of the young fruit, within which it passes through the entire larva and pupa stages. The larva appears to live more on the seeds and stones of the various fruits it attacks than on the pulpy portions of the fruit; in the Loquot especially it appears to eat only the very hard central stone of the fruit. It always makes a hole from the middle of the fruit to the outside, which it enlarges as it grows, and through which its evacuations are ejected. The larva when full-fed is

blackish brown, covered with short coarse black and white hairs or bristles, with a flesh-coloured patch towards the head, and another towards the end of the body; the last three segments of the body are anteriorly flattened as if cut off with a knife, this flattened portion forming a hard circular shield, with which the larva plugs up the hole of the fruit on which it lives. The pupa is brown, bearing some obscure black lines, and is rounded throughout. It is fastened to the interior of the fruit by the posterior end, and by a band of silk across the middle. Before changing to a pupa, the larva comes outside the fruit, crawls to the base, and spins a strong web over the basal portion of the fruit and over some considerable length of the attaching stem, so that should the fruit be separated from the stem it will not fall to the ground. The larva then re-enters the fruit, and changes to a pupa within. On emerging from the pupa it must immediately crawl through the hole to the outside of the fruit, as were it to delay doing so, its expanded wings would prevent its escape. Several observers have noted that the larva is attended by ants. The writer has, however, never seen ants in attendance, nor has he been able to detect the special organs in the body of the larva affected by ants: they may exist, however, and further notes on the subject are desirable.

Every fruit that is attacked by the larva dies before it is full-grown and has ripened, as the heart of the fruit is entirely destroyed by the insect. Were this pest to increase largely in numbers, it would certainly do a vast amount of damage to fruit, as is now the case with the Mango beetle.

The most effective remedy against this pest, if practicable, would be to catch the female butterflies and to destroy them before they have laid their eggs. When once an egg is laid on a fruit, that fruit is almost certainly doomed. As a further prevention against attack for the coming year, if all the fruits with holes in them were gathered and destroyed (burnt or buried), there would be but few butterflies left to lay eggs and to carry on the species during the following season.

MISCELLANEOUS NOTES

BY

E. C. COTES.

Locusts in North-Western India.

The past year has been marked by a general invasion of locusts, which have spread themselves over Sind, Rajputana, the Punjab, North-Western Provinces and Oudh, besides penetrating sporadically into Guzerat, Ahmedabad, Baroda, Khandesh and parts of Central India, and appearing in the Kistna district of the Madras Presidency. They have done a considerable amount of injury to standing crops, especially in Rajputana and Sind. Specimens have been forwarded to the Indian Museum, from Karachi, Marwar, Jeypore, Ajmere-Merwara, Multan, Naini Tal, Rawal Pindi, Kistna, Etawah, Muzaffergarh, Lahore, and Bahraich. They all prove to belong to a species which has been identified as *Acridium peregrinum*, which is said to range throughout the dry country from Algeria, on the west to North-Western India on the east. It has often proved most destructive in Algeria, and is supposed to be the *locust* of the Bible; but it must not be confounded either with the locust which has appeared in Algeria during the past two years, or with the locust which invaded the Deccan in 1882-83, though the latter insect was often referred to in reports under the name of *Acridium peregrinum*.[1]

A detailed account of the various species of Acrididæ (*locusts*) which have at different times invaded sections of India is being prepared by the writer, and two short preliminary notes, showing concisely the chief points that are known about them, are being circulated in the hope that residents in various parts of India will come forward to supplement, from their personal observations, the very scanty record which is all that is at present available on this interesting subject.

A Peach pest.

From Mr. W. H. Irvine of Ranchi have been received specimens of a dipterous insect which has been determined by Mons. Bigot as *Rivellia persicæ* (see p. 192). It

[1] The locust which has proved destructive in Algeria during the past two years is *Stauronotus maroccanus*, while that which invaded the Deccan in 1882-83 probably belonged to the species *Acridium succinctum*. It is particularly necessary to distinguish carefully between the Deccan locust of 1882-83 and the Rajputana species, as there are important differences in their habits which make it that measures applicable for the destruction of the one are not always successful with the other.

is reported as most destructive to peaches in Chota-Nágpur, to a great extent preventing their ripening in that district. Mr. Irvine notices that the grubs of the fly, besides being found in vast numbers in peaches, occur sparingly in mangoes and guavas. The insect can perforate the skin of sound fruit to deposit its eggs, but appears to prefer laying them in spots where the skin has already been broken. It may be noticed that an allied insect, *Dacus oleæ* (see Pascoe's Zoological Classification, p. 121), is destructive to the fruit of the olive in Europe; while a second species, identified by Mons. Bigot as *Dacus ferrugineus?* Fabr., has been reared by Mr. W. J. Simmons in the pulp of decaying mangoes in Calcutta. The following is an extract from Mr. Irvine's letters on the subject:—

"My return home was just a little too late to renew my study of the Peach fruit pest. Happily, however, after careful search, I found three peaches lying on the ground, under the trees, simply swarming with the maggotty larvæ of the pest.

"These I removed to the house, placing them on damp soil in a saucer, covered over with a finger-bowl. The larvæ were far advanced, so I was not surprised to notice very soon after I brought them in that they commenced burying themselves in the soil. On the 4th day I disturbed the soil to find all the larvæ had pupated; and on the 11th day the perfect insects cut out. Enclosed please find a few specimens of the perfect insect and more will follow with the other things I have for you later on. My previous observations incline me to believe the pest invariably prefers depositing her eggs in some incision on the nearly ripe fruit caused by birds or other means; but I have noticed the fly working its sucker or probosces on the perfectly sound fruit, till a small black speck became distinctly visible, but there the matter ended, for the pest unfortunately flew off on my attempting a nearer approach. In Ranchi I think it safe to assert that from half to two thirds of the peach crop is annually destroyed by this pest, according to whether we have early or late rain. To stop the injury, or at least ameliorate the harm done, I intend trying the effect of removing at least six inches of soil from under the trees, during the cold weather, and thoroughly baking the same which must kill all there is in the soil of insect life. I would further recommend the instant removal of all pierced fruits which fall to the ground and the burning of the same, or else the placing of them in a trough of water for at least 24 hours.

"Whether the millions of larvæ that must have pupated in the soil during the peach crop season, when hundreds of decaying fruit fell to the ground, have since taken wing, or remain to hibernate in the soil till next season's crop, is a problem to solve.

"I have noticed a few of these pests, in company with some others of the same order, affecting the guava crop now ripening, but I have not as yet met with the larvæ inside the fruit, which is my present object of study, and regarding which more hereafter."

The Sorghum borer.
Diatraea sp.

The following note has been furnished by the Acting Superintendent of the Khandesh Experimental Farm:—

"I beg to forward the following information on the supposed poisonous property of the Sorghum Borer, brought to your notice by Mr. Woodrow of Poona and published in your valuable 'Notes on Indian Insect Pests,' page 28.

"It has been found in this farm that even healthy, young, immatured stalks of jowari produce similar effect as described in your notes. Bullocks finding their way, through the negligence of their keepers, into young Jowari fields, feed greedily upon the succulent stalks. If not disturbed, they consume a large quantity and exhibit, after a time, the following symptoms :—They look drowsy, standing with their legs thrown out and head drooping, as if unable to support it. They stagger along with difficulty. The belly also is distended. They altogether impress one with the idea that they are intoxicated with spirit. If taken care of and the symptoms of poison looked after, they generally recover. Of course cattle that have been starving before will have a very little chance of recovery after a feed in a young Jowari field. Complaints have also reached us as regards 'the poisonous property' of a young crop of *Sorghum saccharatum*. It may, therefore, be concluded that all those plants which develop sugar in their matured stage possess, while young, some deleterious agent in their composition which is the real cause of the injurious effect produced by them.

"The Sorghum Borer, by checking the growth of jowari and thus leaving it in an immatured stage, may produce similar poisonous effect on cattle. It is, therefore, not the direct cause of the poisoning of cattle feeding upon plants attacked by it.

"The nature of this substance is not yet known and cannot be determined till a series of analyses be made during the several stages of the growth of the plant."

Urticating caterpillars.

From Messrs. Octavius Steel & Co. were received, 11th October 1889, some specimens of a caterpillar covered with urticating hairs. The specimens, though too much decayed for precise determination, were obviously the larvæ of a moth belonging to the group Bombyces.

The following is an extract from the letter of the Manager of the tea estate in South Sylhet where the insects were found :—

"By to-day's post I send you in a bottle a number of caterpillar-looking insects that have been giving me a lot of trouble this year, not destroying the bushes but laming the coolies. I have sixty coolies incapacitated from work owing to this. The caterpillars, or whatever they are, lie under the edge of the bush and the coolie treads on them when plucking; his foot begins to pain, and if not on the hard sole a blister rises, and until this forms into a wound and suppurates he suffers agony and can't walk at all."

Mosquito blight and Red spider in Sikkim.

Information has been received through Mr. Lionel de Nicéville of injury done during the past year to tea in Sikkim by *Helopeltis theivora* (Mosquito blight) and *Tetranychus bioculatus* (Red spider).

The Red spider attacks the tea in spring and early summer, while the Mosquito blight is found during August and September and confines its ravages chiefly to elevations below 2,000 feet. On one tea estate alone the loss caused by the Mosquito blight in the past year was estimated at 300 maunds of tea, valued at ₹20,000; that done by the Red spider being even greater. It is said that the Mosquito blight has only appeared of late years in Sikkim, with the cessation of the practice of annually burning the jungle.

Preparations are being made in one garden, on a considerable scale, for sprinkling bushes attacked by the Red spider with Flour of sulphur, with a view to the destruction of the pest. Sprinkling with flour of sulphur has been found useful in Florida for destroying the Rust mite *Typhloromus oleivorus*, which attacks orange trees. This treatment would therefore be promising for use against Red spider. Washing the orange trees with a solution of whale-oil soap (1 lb of soap to 5 gallons of water) has also been found useful against the rust mite; it is therefore suggested for Red spider, in case the sulphur treatment is not found to be successful.

Teak-borer in Travancore.

Specimens have been forwarded to the Museum of a red-boring caterpillar, probably belonging to the genus Zeuzera. It is reported as doing very serious injury to teak trees in Travancore by boring into the stems. Specimens of the mature insect (moth) should be furnished for precise identification.

The following account is extracted from Mr. T. F. Bourdillon's letters [1] on the subject:—

"The teak tree, as you probably know, occurs in Travancore, and is found over considerable areas, both in the low country and on the hills, up to 3,000 feet elevation. It attains very large dimensions (5 feet in diameter), and grows to a great age at moderate elevations (1,000 feet or so), and on free, well-drained situations, but in the low country it seldom grows much above 15 inches in diameter, the timber here being much heavier, and the concentric rings much closer together, than when the tree grows on the hills. This is probably due more to its growing on a hard laterite soil than on the difference in elevation.

"This small stunted teak is very much troubled by a species of red borer, not quite an inch long, which perforates the wood chiefly in the neighbourhood of the old branches, and of course very much lowers its value. . . .

"This boring is entirely due to the dreadful system of lopping teak to manure the paddy-fields which prevails in Travancore. . . . The trees are lopped in May and June, just when they are in full leaf, little snags being left by the people by which to climb up. These snags die back, and as the sap is in full flow a new branch is thrown out at the side of the old branch, which is in turn cut back, so that gradually large spaces of soft rotting wood about 10 inches square are left at intervals all up the tree. This soft wood is seized on by some insect which lays its eggs there, and in time borers riddle the wood. They work in and down to the distance of 8 or 9 inches and are to be found at work about May and June. . . .

"The trees thus attacked after a time die down from the top, and eventually no part of them remains alive but the base of the stem, from which suckers are thrown up. The very small bee (whose honey is bitter) often takes possession of the abandoned workings of the borer and its combs are found in them.

"The wood is of course completely damaged for furniture or ordinary work, but, when the trees are not badly bored they can be used for rough work, such as posts, though they are of course permanently disfigured.

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[1] The first of these letters was published in the *Indian Forester* of July 1889.

"The tuunel is about the size of a quill, and is not at all straight. There can be no doubt that the damage is caused entirely by the lopping of the trees, for in the forest where the teak is not subjected to this ill-treatment the trees do not suffer in the least."

Eri silk-worms in Assam.

Through the Officiating Director of Agriculture in Assam were received, in the latter part of August last, (1) specimens of a caterpillar which had proved destructive to castor-oil plants, (2) specimens of Eri silk-worms (*Attacus ricini*) which had died of disease which had been very fatal to them in Cachar.

The caterpillar proved to be the larvæ of the Noctues moth, *Achæa melicerte* of Drury, a species which has previously been reported as destructive to castor-oil plants in Lower Bengal and in Madras (*vide* vol. I, pp. 52 and 104 of these *Notes*). The insect is a common one and occurs in India, Ceylon, Celebes, and Australia.

With regard to the Eri worms, the disease appeared, on microscopic examination of the contents of the digestive tract, to be *Flacherie*. The chain ferments, *Strepcococtus bombaycis*, which is characteristic of *Flacherie*, being recognized on one of the slides that were prepared. Ferments of this kind are always difficult to make out in alcoholic specimens, so the not finding it in large quantities is not considered to affect the probability that the disease was *Flacherie*, while Mr. Mackenzie's description of the symptoms, which were precisely those of the *Flacherie* of the mulberry-feeding silk-worm (*Bombyx mori*), leaves no room to doubt the correctness of the diagnosis. The fact is an interesting one, *Flacherie* being so intimately connected with the fermentation of the mulberry leaf, that it might have been supposed that it would not affect the *Eri* worm, which feeds on a totally distinct plant. The well-known Pasteur system, of dealing with the *Flacherie* of the mulberry silk-worm, is no doubt equally applicable to the case of the *Eri*, and need not therefore be entered into here. The following is extracted from Mr. Mackenzie's report, dated 3rd August 1889[1]:—

"During the past month (July) two very serious misfortunes have befallen the enterprise.

"(1) In the beginning of the month *millions* of caterpillars emerged from the jungle and attacked the castor-oil plants, eating every leaf, bud, soft leaf-stalk, and even parts of the barks. They arrived during the night, and when discovered next day[1] had overspread some three or four acres. All available hands were immediately put on to picking them off the plants and killing them, and by evening, though many thousands had been destroyed, the numbers left appeared scarcely diminished. Next morning it was found that they (the caterpillars) had increased in numbers during the

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[1] Since the above was written a series of excellent stained sections have been made, by Mr. Wood-Mason, of one of the diseased caterpillars. These sections fail to show the chain ferment, and the original observation therefore of its presence requires confirmation. The most satisfactory subjects for examination would be live chrysalids raised from deceased worms, the deceased worms themselves, preserved in alcohol, giving uncertain results.

night, and in spite of the most strenuous exertions, by the morning of the third day there was literally not a leaf left throughout the whole area.

"The caterpillars varied in size from 1 to 3 inches, and in colour from grey to black, the smaller (younger) ones being grey and the larger ones black. . . . .

"The supply of castor leaves having thus failed, the worms had to be fed upon the leaves of the 'Keenchor,' 'Juan,' and 'Tenghan-Jang' trees (Mikir names), and they did well until just before they were ready to spin their cocoons, *when almost all of them* displayed the following symptons: they stretched back their heads and necks, 'reached' several times, and with a good deal of difficulty vomited a thick shiny fluid (of a dirty white colour), their bodies becoming quite limp and flaccid; they either fell from the leaves on which they had been feeding or remained hanging caught on some projection. Decomposition was exceedingly rapid, the diseased worms, *almost before death*, emitting a most horrible putrid smell.

"The other 100,000 worms, which had been fed from the commencement on 'Keenchor' leaves and were in a different house, and attended by separate coolies, at almost the same time showed signs of this same disease, and almost all thew orms were dead in two days; they were also commencing to spin their cocoons when attacked.

"The 200,000 worms thus, instead of yielding about 200 ℔ of pierced cocoons, yielded only 17 ℔.

"The disease in its symptoms resembled 'Flacherie' as described by M. Pasteur, but as I have not at present got a microscope of sufficient power, I cannot make sure.

"Every means was taken to check the epidemic, the sick worms removed as noticed and the healthy ones removed to other clean houses, but without result, as the disease again and again broke out. M. Pasteur says of Flacherie:—'La flacherie est éminemment contagieuse; de même que la pébrine, elle peut être héréditaire ou accidentelle (in this case it was not hereditary); elle a diverses causes, une trop grande accumulation des vers a leur différents âges, une température trop élevée au moment des muses, une aération insuffisante, un temps de changement atmosphérique, l'emploi d'une feuille mouillée par le brouillard ou par la rosée, une feuille très dure succédante à une feuille plus disgestive.'

"This last cause might have been the reason of the worms formerly fed on castor and afterwards on 'Keenchor' leaves dying, *but the disease broke out almost simultaneously* in the house containing worms which had from the commencement been fed on Keenchor leaves.

"The houses were quite open round the sides, well ventilated, and kept scrupulously clean, the worms were not crowded.

"The hill tribes round here (Mikir Kookies, &c.) who cultivate the Eri worm inform me that this disease occurs occasionally, but at intervals of years."

Wild silk-moths in Sikkim.

Some time before his death the late Mr. Otto Möller of Darjiling sent down a series of leaves of Sikkim plants upon which he had found the caterpillars of various species of wild silk-moths feeding. He also sent some short notes on the habits of the insects. Dr. D. Prain, of the Botanical Gardens, Sibpur, kindly identified the plants, and it was intended to incorporate the results in the general account of Indian Saturniidæ and Bombycidæ, for which the writer was collecting materials. Pressure of other work has since made it necessary to abandon the idea of writing this general account, but as the notes are of interest they are given below.

Attacus atlas, feeds in Sikkim on a species of wormwood (*Teucrium macrospachyum*) which grows abundantly from an elevation of 6,000 feet upwards.

Attacus edwardsii, found in Sikkim at an elevation of from 6,000 to 7,000 feet. An annual; the moth appears in the rains and hybernates as a pupa.

Attacus cynthia, common in Sikkim up to 5,000 feet elevation; thought to be three-brooded; hybernates as a pupa: food-plant *Zoanthoxylum acanthopodium* or *Z. alatum*.

Actias selene, fairly common in Sikkim at an elevation of from 3,000 to 5,000 feet; bivoltine; the first set of moths appear in early srping, the second in July and August; hybernates as a pupa; food-plant *Zanthoxylum acanthopodium* or *Z. alatum*.

Actias leto, found at low elevations only in Sikkim; bivoltine; the moth appears in spring and again in autumn; hybernates as a pupa; food-plant *Turpinia pomifera*.

Antheræa frithii, common at low elevations in Sikkim; bivoltine; moths appear in March and again in August; hybernates as a pupa; feeds on Sâl (*Shorea robusta*).

Antheræa roylei, is found in Sikkim at low elevations up to 3,000 feet; thought to be an annual; moths appear in April; food-plants *Evodia fraxinifolia* and *Daphniphyllum himalense*.

Rinaca zuleica, feeds, in Sikkim, upon *Actinodaphne sikkimensis* and *Acer caudatum*.

Rhodia newara, found in Sikkim at elevations of from 4,000 to 7,000 feet; annual; the moth appears during the early part of November at 5,000 feet elevation, and somewhat sooner at higher elevations; hybernates in the egg state; the larvæ emerge early in the spring and finish spinning their cocoons by the end of May. Food-plants, weeping willow and wild walnut.

Theophila bengalensis, found in Sikkim at an elevation of 2,000 feet: moths appear in November; cocoons have been found on an orange tree overhung by *Artocarpus chaplasha*, which is the food-plant, the larvæ not feeding on orange.

Bisulphide of carbon for *Calandra oryzæ*.

The following extract from the Annual Report, 1888-89, of the Bhadgaon Experimental Farm has been furnished by the Revenue and Agricultural Department of the Government of India:—

"In pursuance of Government Resolution No. 6093, dated 9th September 1887, Revenue Department, experiments were made to test the efficacy of $C.S._2$ as a preservative of grain from the attack of weevils, and upon which a separate report was submitted in August last. The observations were continued this year.

"A summary of the results of the experiments is given below :—

(*a*) That soft varieties of grains such as soft wheats and jowari are sooner attacked with weevils than hard varieties, as *bansi* wheat, *bájri*, &c.

(*b*) That $C.S._2$ is a perfect preservative against the attack of weevils upon grain.

(*c*) The action of $C.S._2$ lasts in cases not hermetically closed six weeks, after which period a fresh charge of the reagent is required.

(*d*) That even in samples which have been attacked with weevils the effect of $C.S._2$ is immediately felt, the weevils disappearing *en masse*.

(*e*) That $C.S._2$ does no harm to grain as regards its colour, smell, and cooking properties, &c.

(*f*) That the poisonous property of $C.S._2$ need in no way interfere with it introduction into Indian villages, as, unlike arsenic, its strong and repugnant smell will act as a sufficient safeguard.

(*g*) With the dismantling of the old granary, which had been used as a store-house for grain for the last nineteen years, weevils have almost disappeared from the farm. After a long and diligent search, I succeeded in observing only a few under the heaps of jowari ears in the threshing yard, so late as the 20th of the last month. This proves beyond doubt that wheat is damaged most by weevils in city godowns, where a large quantity of it is stored every year before being shipped to Europe.

(*h*) It is therefore fair to conclude that painting the interior of the godows with poisonous paints and charging the grain with $C.S._2$ (in the proportion of $1\frac{1}{2}$ ℔ of the reagent to a ton of grain) will reduce the damage caused by weevils to wheat and other grains to a considerable extent. . . ."

Grape pests.

From the Deputy Commissioner, Simla District, have been received specimens of diseased grapes, together with a report upon them by the Deputy Conservator of Forests of the Bashahr Division. The following is an extract from this report :—

"The first sign of the disease which attracts notice is a white powder-like substance on the skin of the grape occurring in July, and spreading till the whole fruit and peduncle is covered, when some of the grapes and their stems shrivel up. Others more vigorous outgrow this phase (if it is a phase—it may be a distinct disease), but as the colouring and ripening commence, the grape splits, and if examined, grubs are found inside. The splitting commences in July. Additional moisture in the air and unusually heavy rain increase the disease. Increased free circulation of air, and by carrying up the vine above surrounding vegetation, lessen it. Rubbing, syringing with mustard oil and deodar oil, washing with soap and water, sprinkling young buds, flowers and fruit with sulphur when the dew is on them has been tried with no apparent result in decreasing the pest. An autumn pruning resulted the year after in some bunches being untouched, but the pruning was not continued, and in the third year the pest returned with its usual vigour. In other vineyards a partial immunity in some years occurs, notably in dry ones.

"No eggs have been discovered. There appear to be two kinds of pupa ; two kinds of flies, one black, the other grey ; and one kind of plant-louse. The worm from which the fly in box No. 4 is produced is active and holds on by a hook to parts of plant very tenaciously. The grey powder or mildew cannot be accounted for ; it is at first

like dust, but in a little while hardens; besides the dust, many little brown specks occur."

The "flies" forwarded consist of larvæ, pupæ, and two imagos of a small dipterous insect not unlike that found on decaying fruit in Bengal. Some of the specimens can be determined and will be sent to Europe for this purpose. It appears probable that these insects may attack the grapes after they have begun to decay from some other cause, such as a fungoid disease: the specimens therefore have been submitted to the botanical authorities in case they are able to throw any light on the subject. Besides the dipterous insect, one empty chrysalis of a small moth has been received; the precise identity of this species cannot be determined without an examination of the imago; the insect, however, is not likely to have anything to do with the damage reported.[1]

Acrididæ in Guzerat and the Central Provinces.

From the Deputy Commissioner, Bilaspur, and also from the Settlement Officer, Raipur, have been received specimens of an orthopterous insect (Acrididæ) known locally as *Papha*, said to have done considerable damage to young paddy and *Kodo* (small millet) in the Central Provinces during the rains of 1889: it is also reported to have been prevalent in Raipur in 1886.

This insect is very closely allied to the species forwarded by the Honorary Secretary of the Bombay Natural History Society, as having done an immense amount of damage in Kathiawar in August 1889.

The specimens have been kindly examined by Dr. Henri de Saussure, who reports that the Gujerat insect belongs to a new species of *Hieroglyphus* which he proposes to describe under the specific name of *colesiana;* while the specimens from the Central Provinces belong to the two species *Hieroglyphus furcifer*, Serville, and *Euprepocnemis bramina*, deSaussure.

Tea *Dasychira.*

The following note on the Perilampus described on page 32 of No. I as parasitic on *Dasychira thwaitesii* has been received from Mr. L. O. Howard, Acting United States Entomologist:—

"May I call your attention to one little matter which interests me particularly for the reason that I have for a number of years been studying *Hymenopterous* parasites? Among the parasites of the *Dasychira* which injures tea, I notice that you have *Tachinids*, a *Chalcis*, and a *Perilampus*. Judging from what we know of the habits of *Perilampus*, it seems to me more likely that it was parasitic upon the *Tachinid* than upon the *Dasychira*, and it will, of course, be an interesting point for you to settle."

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[1] Help in examining these specimens was most kindly afforded by Dr. D. Prain.

Caterpillars that attack tea in Assam.

Specimens were received in the end of September from Mr. Donaldson of Dhubri, with the information that the insects had attacked the tea plants and were to be found over half the garden. The specimens proved to be caterpillars of one of the Psychidæ Moths (probably *Eumeta cramerii*), together with empty chrysalid cases of one of the Limacodidæ moths, the materials in each case being insufficient for precise determination.

Tea-leaf miner fly.

In a letter, dated 13th July, Mr. E. Green of Ceylon wrote :—

"The larva mines below the cuticle of the upper surface of tea leaves. I do not know that the pest is of any real importance, as it only attacks leaves too old for plucking. The habits of the larva are interesting, however. From its being laterally compressed, it accordingly rests upon its side beneath the cuticle of the leaf. It feeds very rapidly, clearing a space more than twice its own size in half an hour's time,—the head and anterior segments moving in regular sweeping curves like a mower with a scythe. Before pupating, the larva assumes the usual horizontal position, so that the preparium rests upon its abdominal surface."

The specimen was submitted to M. Bigot, who determined it as a Dipterous insect (Fam. Muscidæ), belonging to a hitherto undescribed species of the genus *Oscinis*.

Butterfly destructive to Cocoanut Palms.

Specimens of the Hesperid butterfly, *Gangara, thyrsis*, Fabr., have been received through the Director of the Forest School, Dehra, from the District Forest Officer, North Malabar, who reports that the caterpillar is very destructive to young cocoanut palms. The following is extracted from his report :—

"The egg, which is spherical in shape, is laid on the upper surface of the frond. The larvæ appear in from 8 to 10 days, and immediately draw a section of the leaf together, first cutting it laterally to enable it to be drawn into a cylinder by means of fine silken thread. In this cylinder the larvæ live, travelling out at night to feed.

"In appearance the larvæ somewhat resemble that of *Attacus atlas*, but are, of course, very much smaller. They are covered with white filaments which appear as if powdered with flour. There are two patches of scarlet on the segments near the head, placed laterally."

Insect attacking the "*Farash*" tree.

From the Deputy Conservator of Forests, Multan, have been received specimens of the cases ("webs") made by a Homopterous insect probably belonging to the genus *Machærota* and allied to the species described by Westwood from Ceylon (Trans. Ent. Soc. Lond., 1886, p. 329).

The following is an extract from the report :—

"When fresh these webs are elastic and can be pulled out to ten or twelve times their own lengths without breaking. It is rather rare on the *Farash* (*Tamarix articulata*), and I have not observed it on any other tree, nor could I find any insect. The damage done so far is small; the twigs attacked by the insect dry up."

Indigo pests.

Through the Director of Agriculture, North-Western Provinces, have been received specimens of insects said to be known as *gadhao*, which feed on the leaves of the young indigo plant and which are reported to have caused considerable injury in the Middle and Lower Doab this year, the insects being also said to feed largely on the leaves of carrots and cabbages. The specimens proved to belong to two species of *Acridid orthoptera*; the first is a species of *Chrotogonus* which has been forwarded on several occasions to the Museum as injurious to indigo; the second cannot be precisely determined in Calcutta and is being sent to Europe for comparison with type specimens.

The Rice Sapper, *Leptocorisa acuta*.

Through the Director of Agriculture, Assam, has been received a report, dated 17th September, by the subdivisional officer, Karimganj, Sylhet, accompanied by paddy ears with empty husks, the grain having apparently altogether failed to develop, owing to its having been attacked when immature by *Leptocorisa acuta* (the rice sapper). The following is an extract from the report:—

"I cannot obtain specimens now, and have not examined the insect so closely as to be able to describe it in detail and by means of technical terms, but I find it to be the insect described as the Rice Sapper (*Leptocorisa acuta*) in page 1 of the *Notes*. Its form is reproduced in pl. 1, figure 1, attached, but its size is smaller than that shewn in figure (*b*). It is of a greenish colour and not spotted. It emits a most offensive smell, similar to, but more intense than, that of household bugs. The offensive odour is very persistent on anything which the insect touches. Insects of precisely the same nature are called *gandhis*; they seem to obtain the name '*mohua*' when they attack the dhan fields. *Gandhis* are more or less common every year.

"2. The insect settles on the rice before it hardens into grain, and sucks out the milky juice, leaving dry husks only. The effect on *dhan* can be seen from the *dhan* which I sent in along with my letter No. 1143, dated 5th September last.

"3. The insects attack only *murali* and *aus* dhan, about the months of July and August. It is said they appear when there is a sudden stop of rain after a continuous fall and the sun comes hot and bright. I cannot find that any remedy has been tried to stop their depredations.

"4. I have been unable to procure eggs or obtain any information of its life-history."

Specimens of *Leptocorisa acuta* have also been forwarded from the Deputy Commissioner of Sylhet, where the insect was said to have done considerable damage to rice in the latter part of the rains.

The following also, which appeared in the *Ceylon Observer* of 4th November on the subject of the rice sapper, is of interest:—

"We have received from Mr. Drieberg, Superintendent of the School of Agriculture, the following response to queries of ours:—

"'I am sorry that my teachers cannot supply the Sinhalese and Tamil names of the

insects mentioned as pests in Ceylon, and they seem to think there are no distinctive names. I enclose a note on the rice sapper by Mr. Jayawardene :—

"'The rice sapper' (*Leptocorisa acuta*, or *varicornis*).

"'Sinhalese name—*goyan messa;* Tamil name—*vandu.*

"'This insect is commonly known in Ceylon as the "paddy fly," but it is a member of the bug family, and possesses the characteristic offensive smell. Perhaps it has gained its Indian name of *gandhi* on account of this offensive smell. *Ganda* in Sinhalese too means a bad smell.

"'The pest is very destructive to paddy. Sometimes large tracts of fields have to be left without cutting as there is no crop to be gathered, the insects having sucked out the juice while the grains of paddy were still young and leaving the husk dry. On approaching an infested field the presence of the pest may be made out by the offensive smell which prevails. They are found in such numbers in some fields that I have seen the ears of paddy actually bending under the weight of the insects on them.

"'Both the "yala" and "maha" paddy are attacked. The insects were found in a plot of dholl in the school garden sucking the juices from the immature pods. The insects were found paired on the dholl trees, and a female was placed under a bell for observation and laid eggs, but these were very unfortunately destroyed by ants.

"'There is no doubt that the pest breeds in paddy-fields, as I have observed the insect in all the stages on paddy-plants. An alternative brood is hatched in the jungle when the fields lie fallow.

"'*Methods employed for destroying the pest.*—1. *Charming* (!) is resorted to with very great success according to the villagers. Probable explanation of success when such is the case—a change in the weather. High winds and rain drive the pest from the fields to seek shelter in the neighbouring jungles.

"'2. *Smoking* by burning certain aromatic herbs and resinous substances to windward—very often attended with great success.

"'3. *Ropes* saturated with resin oil or kerosine oil are drawn over the fields with doubtful success.

"'4. *Bokugema*, which is the only effectual way of getting rid of the pest. A paddy-winnow is taken and a glutinous substance, generally the *coagulated milk* of the jak, is rubbed on the inside. This is tied to a long pole and the ears of paddy are brushed with it, when the insects are found adhering in large numbers. The winnow is now held over a fire and the insects killed. The process is repeated over and over again."

The identification of Coffee pests in Ceylon.

Mr. E. E. Green furnishes the following notes regarding the identification of the species described in the paper by the late Mr. Neitner on Coffee pests in Ceylon :—

Orgyia ceylonica, Neitner, is probably synonymous with *Orgyia postica* of Moore, the larvæ of the latter often occurring in large numbers upon coffee trees :

Trichia exigua of Neitner corresponds to *Somena irrorata*, Moore, or *Somena scintillans*, Walker :

Agrotis segetum of Neitner is probably either *Agrotis conspurcata*, Walker, or *Agrotis suffusa*, Fabr.; the true *Agrotis segetum* not having been observed in Ceylon :

Boarmia ceylanicaria is probably *Boarmia diffusaria*, Walker; while the identity of *Galleriomorpha lichenoides* has, it is feared, been completely lost.

It is much to be regretted that representatives of the various coffee pests that were described by the late Mr. Neitner were not deposited at the time in some local museum where they could be examined and their identification settled. It is hoped, however, that as specimens and information accumulate in the Indian Museum, it will be possible to determine and to publish accurate figures of at least the more important of the insects described by Mr. Neitner.

Bot flies in India.

Attention has been called by Miss Eleanor Ormerod to the amount of damage annually occasioned by Bot flies (*Oestridæ*) in India. She notices that it had been reported to her that hides shipped from Calcutta, Madras, and Bombay were depreciated perhaps to the extent of 50 per cent. on 10 per cent. of the skins, while those from Karachi had an average of about a quarter damaged to the extent of 60 or 70 per cent. A report by one of the Calcutta hide merchants has since been quoted in *Hayes' Sporting News*, where it is stated that in shipments from Calcutta, warbled hides are chiefly to be found in parcels which have come down from the North-Western Provinces and the Punjab, fully 50 to 75 per cent. of the hides being affected; while in Bengal proper there are no warbles at all. The warbled hides are chiefly found amongst those which come into the market between November and January, hides being sometimes riddled down the centre (along the backbone) by as many as 500 warble-holes and thus reduced to but an eighth of the value they otherwise would have. Deer are similarly affected, and horses and goats also suffer, though the damage done to goat-skins is not so great as to hides, and the warble probably belongs to a distinct species.

Beyond the fact of the very serious loss which is annually occasioned by Bot flies in India, little seems to be known about them, though it is probable that their habits are very similar to those of Bot flies in Europe, where, however, it is likely that the insects belong to distinct species. Miss Ormerod has shown that much can be done to prevent injury from these insects in England, and it would appear most desirable to study them in India with a view to recording their life-histories and ascertaining to what extent it may be possible to combat them there. The observation that Bot flies are not found in Lower Bengal is a curious one and requires explanation; it would seem analogous to the well-known fact that house flies are much more common in the dry plains of the North-West than in the steamy plains of Lower Bengal, where, however, the conditions that obtain seem singularly favourable to their increase.

Museum pests.

During the past rains the well-known coleopterous pests *Anthrenus vorax* and *Tribolium castaneum* were again reported as troublesome in the Indian Museum, the former to dried mammal skins, the latter to bran used for packing. Specimens of *Lasioderma testaceum* were also obtained from Burma cheroots, thus confirming the observation that this is the beetle which so often destroys cheroots by tunnelling into them.

Apple scale in Coonoor.

From Mr. Daly of Coonoor have been received specimens of a scale insect (supposed to be *Schizoneura lanigera*), with the information that it has done great damage to nearly every apple-orchard in Coonoor, attacking both the roots and branches of the trees. The insect is said usually to commence its operations on the roots, and this makes it extremely difficult to ascertain its presence and to adopt remedies before it has obtained such a hold upon the orchard as to be practically ineradicable. In some orchards, as soon as a tree is found to be infested, it is cut down and the roots are dug up and burnt. Kerosine emulsion, however, when applied at an early stage of the attack, appears likely to render such radical measures unnecessary. Tomato planted round the apple trees is said to preserve them from the attack; this observation, however, requires confirmation.

The following is an extract from Mr. Daly's letter:—

"Out of four hundred apple trees I found about six unmistakeably affected. I cut all branches badly attacked and burned them. I then mixed a solution of soap (common country) and petroleum with a little turpentine and boiling water, stirring round until it was the consistency of butter. After allowing it to get cool I mixed one bottle of this with twelve of water and applied it with a garden syringe to the branches and roots. I also applied the soapy congealed matter to any of the insects concealed in the crevices of the trees and also to the trunks. A few days after this I applied in the same manner a mixture of lime and ashes, with a little salt mixed. This dries up the lichen and causes it to fall off during the prevalence of rain. I commenced this treatment about ten days ago, and to-day (13th of November) I cannot find a single insect, but I am told it is not improbable that they may return: however, I shall keep a sharp look-out for them. The kerosine and soap emulsion does not seem to harm the trees."

Specimens of the pest have since been received from Bangalore, where it is said to be doing very serious injury. A general account of it is being prepared by Mr. E. T. Atkinson for publication in an early number of these *Notes*.

Pea and gram weevils.

The large grey Bruchid which attacks stored peas in Calcutta, eating out the interior of the pea and leaving little more than an empty skin, much in the way that the weevil *Calandra oryzæ* eats out the contents of grains of wheat and rice,

has been kindly examined by M. Bandi de Silve, who determines it as *Bruchus* (?) *emarginatus*.

The small brown Bruchid which attacks stored gram in a similar manner, and which has been sent to the Museum by the Collector of Nuddea, who calls it *ghora poka*, and also by the Collector of Ganjam, who calls it *pesala puruga*, has been determined by M. Bandi de Silve as *Bruchus chinensis*.

The life-history of neither of these insects appears to be known, though, in each case, it is likely to resemble that of the allied *Bruchus pisi* of Europe.

Scale-insects on tea.

From Messrs. Mitchell, Reid & Co., of Calcutta, were received, on 29th June 1889, specimens of a scale insect determined by Mr. E. T. Atkinson as *Lecanium theæ*. Messrs. Mitchell, Reid & Co. wrote :—

"We have received from our Holta TeaGarden, in the Kangra Valley, some prunings from a tea-bush showing a species of blight, which, our manager advises us, has made its appearance and threatens to spread. The manager says it was first noticed in a garden which largely used castor cake for manure, and he expresses his opinion that the blight resembles that which affected and ultimately ruined the coffee industry in Ceylon . . . . The prunings, which we send herewith, show the blight referred to."

On 3rd July Messrs. Mitchell, Reid & Co. again wrote :—

"In a letter received from the manager this morning he informs us that the pest is distinctly spreading, though in a most irregular manner. Healthy and weak bushes are alike attacked ; a few bushes may be attacked in the middle of a plot in the valley and the pest not appear again for miles, while some gardens have it in a much more aggravated form."

This insect belongs to the same genus as the well-known Coffee scale of South India and Ceylon, and there is little doubt but that it can be destroyed by the kerosine and soap solution recommended for destroying that insect.

Caterpillars destructive to paddy in Prome (Burma).

The following report by the subdivisional officer, Prome, on caterpillars destructive to young paddy in nurseries in the district, has been received through the Department of Agriculture, Burma. The damage occasioned appears to have been considerable ; it is desirable, therefore, that specimens, in various stages of development, should be forwarded for determination, so that the identity of the insect may be ascertained.

"With reference to your Revenue Department No. 21—8, dated the 15th August 1889, I have the honour to report on the damage done to the nurseries in certain parts of the Mahathaman township. It appears that the warmth of the weather which followed a few showers of rain in the early part of July was favourable to the development of the butterflies' eggs which had been deposited on the grass, while the continuance of a few cloudy days materially promoted the rapidity of the growth and

the spread of the caterpillars known as *daungde* over an area of more than three thousand acres. It was on or about the 11th July last when these caterpillars first made their appearance in a few nurseries in the Alodawya Wethgan circles. They were originally of the size of the lead of an ordinary pencil, but in about ten days they grew four or five times larger than the original size, and their spread became general throughout the above-mentioned two circles. In size and appearance they are exactly like the caterpillars usually seen in vegetable gardens. The only difference is that these caterpillars are multipedal and can creep slowly, although not so fast as the centipedes. They are known to feed upon tender grass and leaves of young plants like other caterpillars.

"In my opinion the caterpillars now in question belong to the genus Perilatus. The destruction of crops was confined only to the two circles above noted, affecting about 3,015 acres, and the damage done to the nurseries in other circles is trivial; it is not worth while to note them. It appears that these insects commenced their attack from the top of the stalk, which they ate up till there was nothing tender left. The same pest occurred about eight years ago, although not to the extent that was seen this year. The ash of the paddy husk or tobacco stalks and leaves is known to have been scattered over the parts attacked as a measure for destroying these larvæ, and other like measures were also adopted without any success. A few heavy showers of rain are, however, known to have caused their vanishment. In the same way the recent heavy showers that we have had have caused the entire disappearance of the caterpillars now in question.

"This clearly shows that the simplest method of killing the larva is to drown them. Fresh seeds have since been sown in places where damage was done, and the affected nurseries which caused so much anxiety have again resumed a green and healthy appearance. As the matter now stands, it is not probable that there will be any short outturn of crops, as was anticipated about a month ago."

A rice caterpillar.

In a local report dated 6th August 1889, received from the Officiating Commissioner of Settlements and Agriculture, Central Provinces, it is noticed that the pest which is known in Sambalpur as *Harnipok*, and which has been identified as probably belonging to the Noetues moth, *Leucania loreyi*, is usually very abundant in rice-fields in August, though but very few have appeared this season (1889).

Prodenia littoralis.

The following note has been received from Mr. T. Cleghorn of Balasore on a Noctues moth, *Prodenia littoralis*, which feeds on mulberry bushes :—

"Two perfect insects of this caterpillar with their empty chrysalis cases forwarded. These two caterpillars were found in the mulberry plantation, when half grown, and were reared to maturity in confinement. The animal is very tame and easily reared. It spins no cocoon, but when the time arrives for its transformation into the chrysalis stage, it goes to ground and buries itself about two inches deep near the roots of the mulberry plant. It has the power of postponing its transformation, when it has done feeding, and does not go to ground if the ground be too wet. One in confinement was thus made to wait four days, by having the earth in its cage in a semi-liquid

state: when dry earth was given, it immediately buried itself and transformation into the chrysalis stage took place without delay. It only feeds at night-time, and during the last four days of its caterpillar life it will consume a large leaf of the *Morus alba* nightly. Life-history during August is—14 days caterpillar stage with four moultings; 7 days in chrysalis stage; 3 days moth stage."

Defoliation of teak by caterpillars.

Mr. Fernandez, of the Forest School, Dehra Dun, writes that teak trees over square miles of forest in the Central Provinces are sometimes completely defoliated, during the latter half of the rainy season, by caterpillars, which pass their pupal stage in the ground, and when alarmed on the trees drop themselves to the ground by silken threads. The insect is probably a Noctues moth. Specimens should be furnished for determination.

Strobilanthus weevil.

From the Director of the Forest School, Dehra Dun, have been received specimens of a curculionid said to destroy the seed of *Strobilanthus pectinatus* (kibu) in Darjiling. These have been forwarded to Europe for comparison with type specimens.

Tusser Tachinid.

In the cabinets of the Indian Museum are some tachinid flies which were received from Singhboom, where they were said to be parasitic upon Tusser (*Antheræa mylitta*) caterpillars. No further particulars appear to have been furnished regarding the habits of the insect, but as it appeared desirable to have its identity established, the specimens were submitted to Mons. J. M. F. Bigot, who has determined them as belonging to the species *Masicera grandis* of Walker.

Maldah Jute Pest.

From the Collector of Maldah were received (8th July 1889), through the Director of Land Records and Agriculture, Bengal, some specimens of a caterpillar said to injure jute plants.

The caterpillars are Noctues larvæ and have some resemblance to the larvæ of a moth belonging to the genus *Aletia*. They cannot, however, be precisely determined without an examination of the moth into which they develop. Specimens, therefore, of the moth, or live chrysalids from which moths can be reared in the Indian Museum, should be obtained for examination.

Berhampur Pests.

From Babu N. K. Mukarji of Berhampur have been received—(1) Dipterous larvæ said to be destructive to gourd; (2) Microlepidopterous larvæ, allied to the sugar-cane borer, *Diatræa saccharalis*, Fabr., said to bore into the stems of brinjal;

(3) Larvæ of an obscure lepidopterous insect which bores into bean-pods. Specimens of the fully-developed insect should in each case be sent to enable them to be determined precisely.

Backerganj Pests.

Through the Director of Agriculture, Bengal, were received in November last, from the Officiating Collector of Backerganj, specimens of insects said to be known as *Pamari* and *Magra*, respectively. The *Pamari* insect is the beetle *Hispa œnescens* reported on in vol. I, page 37, of these *Notes;* it is well known as destructive to rice in Bengal.

The *Magra* insect, which also attacks paddy-plants, has not been recognized under this name, and the specimens, which consisted of pieces of tunnelled straw containing dry pupæ cases of a small moth, are not sufficient for precise identification. A Microlepidopterous insect which tunnels the stalks in a similar manner has been reported on as destructive to paddy in Perak (see Wray's Report on the *Paddy borer* in Perak).

Fresh specimens are promised when the insect appears next rains.

Cawnpore Pests.

From the Director of Land Records and Agriculture, North-Western Provinces, have been received the following specimens of insects said to be destructive to crops.

(1) The Hemipterous insect *Dysdercus cingulatus*, said to be known as *jhanga* and to attack vegetables such as the bottle gourd (*Lagenaria vulgaris*).

(2) Acridid orthoptera, said to be known as *Bhunga* in Oudh and as *Aukh-phutta* in the North-Western Provinces, and to destroy the leaves of sugar-cane and jowar. The specimens have been sent to Europe for further examination.

(3) Insects said to be known as *Reotha* and to attack young sugar-cane. These consisted of caterpillars, which are probably the larvæ of the sugar-cane borer moth *Diatræa saccharali;* ; also larvæ and pupæ of a dipterous insect, which probably only feeds on sugar-cane that has become rotten owing to the attack of the borer caterpillar.

(4) Insects said to be known as *Sonri* and to attack the roots and cobs of maize. These consisted of the caterpillar of the butterfly *Danais chrysippus*, Linn., and also of specimens of the red Hemipterous insect *Spilostethus militaris*, Fabr.

Chingleput Forest Pests.

Specimens of insects said to be injurious have been received through the Director of the Forest School, Dehra Dun, from the District Forest Officer, Chingleput.

The specimens comprise:—(1) small insects found on the young leaves of date palms, said to suck the juice of the stems, causing them gradually to wither and die. These belong to no less than four distinct

species referable to widely different groups of Coleoptera: it is improbable that they are all of them concerned in causing the injury that is reported. The species represented numerically by the greatest number of specimens is a beetle belonging to the family Chrysomelidæ, the members of which generally feed on leaves. The precise determination of the species will be furnished hereafter. (2) A large black insect said to be found in the heart of the date palm, and to cause the tree to become sickly and die. This is a coleopterous insect belonging to the family Tenebrionidæ, and determined as *Platynotus excavatus*; it has not previously been reported as injurious to date palms. (3) Caterpillars found in the bark of casuarina trees, and said to stunt their growth, though not to kill them. These are the larvæ of a Lepidopterous insect, probably belonging to the Hepialidæ. They cannot be precisely determined without an examination of the moth into which they transform. The casuarina trees should, therefore, be kept under observation and specimens of the moth secured for examination as soon as they emerge. (4) Large curved grubs said to bore into the heart of casuarina trees and thus affect their growth. These are coleopteræ, apparently belonging to the subfamily Melolonthini. Specimens of the beetle into which they transform should be procured for examination, though there would appear to be some doubt as to their power to injure the trees in the way that has been supposed.

Fig 1.

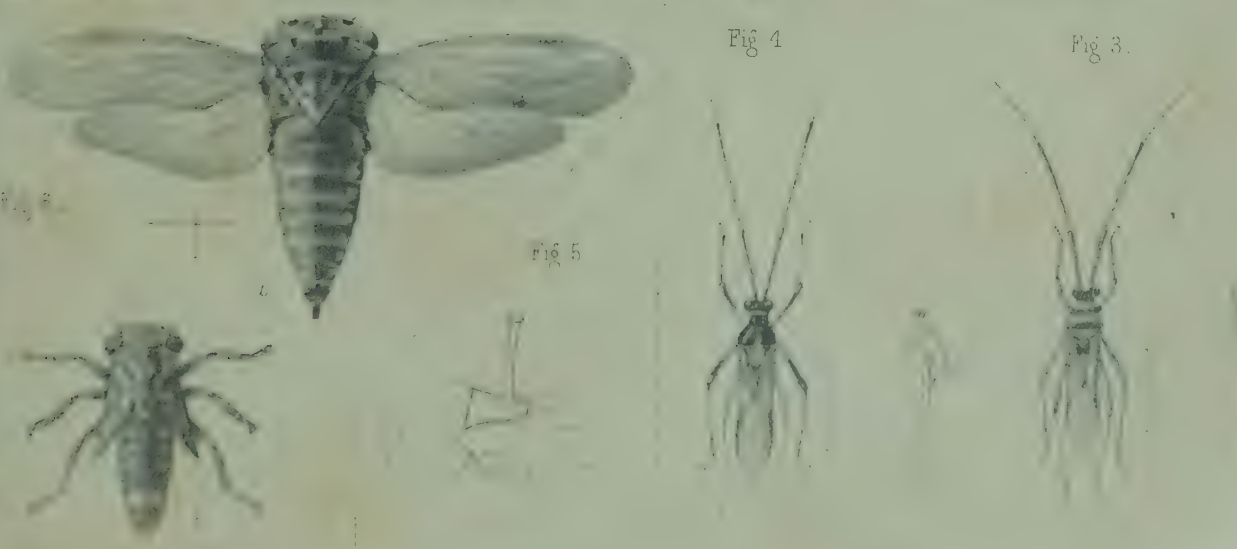
Virachola isocrates, FABR.

Fig 2.

Helopeltis theivora

Fig 4

Fig 3.



Helopeltis antonii.
after a Fig by Signoret.

Helopeltis pellucida, STÅL.

H. collaris, STÅL.

from the original pencil Drawings Survey of India Offices, Calcutta, February 1890